JC07 Rec'd PCT/PTO 26 APR 2001

09/830516

Practitioner's Docket No. AP9455

CHAPTER II

TRANSMITTAL LETTER
TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/EP99/07684	13/October/1999	27/October/1998
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

Method and Device for Conditioning a Received Signal that Transmits Coded Data
TITLE OF INVENTION

Wolfgang Fey; Ling Chen
APPLICANT(S)

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1 492(a)) The 30-month time limit may not be extended 37 C.F.R. § 1.495.

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the*

CERTIFICATION UNDER 37 C.F.R. 1.10*
*(Express Mail label number is **mandatory**.)*
(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date 4/26/01, in an envelope as "Express Mail Post Office to Addressee," Mailing Label Number EL 781 402 160US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Joyce Krumpe
(type or print name of person mailing paper)

Joyce Krumpe
Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1 8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

****WARNING:*** *Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing 37 C.F.R. 1 10(b).*
*"Since the filing of correspondence under § 1 10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

09/830516

JC18 Rec'd PCT/PTO 26 APR 2001

national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. §1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. §1.8

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 C.F R § 1 494(f)

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2.Fees

<table>
<tr><td>CLAIMS FEE</td><td>(1) FOR</td><td>(2) NUMBER FILED</td><td>(3) NUMBER EXTRA</td><td>(4) RATE</td><td>(5) CALCULA-TIONS</td></tr>
<tr><td>[ ]*</td><td>TOTAL CLAIMS</td><td>28 - 20 =</td><td>8</td><td>x $ 18.00 =</td><td>$144.00</td></tr>
<tr><td></td><td>INDEPENDENT CLAIMS</td><td>3 - 3 =</td><td>0</td><td>x $ 78.00 =</td><td></td></tr>
<tr><td></td><td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $260.00</td><td></td></tr>
<tr><td>BASIC FEE**</td><td colspan="4">[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY
Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO:
[ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) $96.00
[ ] and the above requirements are not met (37 CFR 1.492(a)(1)) $670.00

[X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY
Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO:
[ ] has been paid (37 CFR 1.492(a)(2)) $760.00
[ ] has not been paid (37 CFR 1.492(a)(3)) $970.00
[X] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) .... $860.00</td><td></td></tr>
<tr><td></td><td colspan="4">Total of above Calculations</td><td>= 1004.00</td></tr>
<tr><td>SMALL ENTITY</td><td colspan="4">Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR 1.9, 1.27, 1.28)</td><td>-</td></tr>
<tr><td></td><td colspan="4">Subtotal</td><td>1004.00</td></tr>
<tr><td></td><td colspan="4">Total National Fee</td><td>$ 1004.00</td></tr>
<tr><td></td><td colspan="4">Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".</td><td></td></tr>
<tr><td>TOTAL</td><td colspan="4">Total Fees enclosed</td><td>$ 1004.00</td></tr>
</table>

*See attached Preliminary Amendment Reducing the Number of Claims.

i. [ ] A check in the amount of ___________ to cover the above fees is enclosed.

ii. [X] Please charge Account No. 18-0013 in the amount of $ 1004.00 . A duplicate copy of this sheet is enclosed.

***WARNING:* *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b)*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application The provisions of § 1.136 apply to the period which is set Notice of Jan 3, 1993, 1147 O.G. 29 to 40.*

3. [X] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20 At the same time, the International Bureau notifies applicant of the communication to the Office In accordance with PCT Rule 47 1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date " Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below*

a. [X] is transmitted herewith.

b. [ ] is not required, as the application was filed with the United States Receiving Office.

c. [ ] has been transmitted

i. [ ] by the International Bureau.
Date of mailing of the application (from form PCT/IB/308): __________.

ii. [ ] by applicant on ______.
Date

4. [X] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):

a. [X] is transmitted herewith.

b. [ ] is not required as the application was filed in English.

c. [ ] was previously transmitted by applicant on ________________.
Date

d. [ ] will follow.

5. [ ] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: *The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.*

a. [ ] are transmitted herewith.
b. [ ] have been transmitted
  i. [ ] by the International Bureau.
  Date of mailing of the amendment (from form PCT/IB/308): __________.
  ii. [ ] by applicant on _______.
  Date
c. [ ] have not been transmitted as
  i. [ ] applicant chose not to make amendments under PCT Article 19.
  Date of mailing of Search Report (from form PCT/ISA/210): __________.
  ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [ ] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):
a. [ ] is transmitted herewith.
b. [ ] is not required as the amendments were made in the English language.
c. [ ] has not been transmitted for reasons indicated at point 5(c) above.

7. [x] A copy of the international examination report (PCT/IPEA/409)
  [x] is transmitted herewith.
  [ ] is not required as the application was filed with the United States Receiving Office.

8. [x] Annex(es) to the international preliminary examination report
a. [x] is/are transmitted herewith.
b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [ ] A translation of the annexes to the international preliminary examination report
a. [ ] is transmitted herewith.
b. [ ] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115
a. [ ] was previously submitted by applicant on ____________.
  Date
b. [ ] is submitted herewith, and such oath or declaration
  i. [ ] is attached to the application.
  ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.

09/830516
JC13 Rec'd PCT/PTO 2 6 APR 2001

iii. [x] will follow.

Other document(s) or information included:

11. [x] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
   a. [x] is transmitted herewith.
   b. [ ] has been transmitted by the International Bureau.
   Date of mailing (from form PCT/IB/308): ________________.
   c. [ ] is not required, as the application was searched by the United States International Searching Authority.
   d. [ ] will be transmitted promptly upon request.
   e. [ ] has been submitted by applicant on ________________.
   Date

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
   a. [X] is transmitted herewith.
   Also transmitted herewith is/are:
   [X] Form PTO-1449 (PTO/SB/08A and 08B).
   [X] Copies of citations listed.
   b. [ ] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
   c. [ ] was previously submitted by applicant on ________________.
   Date

13. [ ] An assignment document is transmitted herewith for recording.

A separate [ ] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or[ ] FORM PTO 1595 is also attached.

14. [X] Additional documents:
   a. [ ] Copy of request (PCT/RO/101)
   b. [x] International Publication No. WO00/25490
   i. [ ] Specification, claims and drawing
   ii. [x] Front page only
   c. [X] Preliminary amendment (37 C.F.R. § 1.121)
   d. [ ] Other

15. [X] The above checked items are being transmitted

09/830516
JC18 Rec'd PCT/PTO 2 6 APR 2001

a. [X] before 30 months from any claimed priority date.
b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on ____________, namely:

____

____

____

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: *"A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).*

NOTE: *"Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).*

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 18-0013.

[X] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

[X] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: *Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.*

[X] 37 C.F.R. 1.17 (application processing fees)
[X] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[ ] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: *Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of*

allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[X] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 33,373

Joseph V. Coppola, Sr.
(type or print name of practitioner)

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09/830516
JC18 Rec'd PCT/PTO 2 6 APR 2001

AP9455

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Fey et al.

Int'l Application No.: PCT/EP99/07684

Int'l Filing Date: 13/October/1999

Serial No.: Group Art Unit:

Filed: Herewith Examiner:

For: Method and Device for Conditioning a Received Signal that Transmits Coded Data

Attorney Docket No.: AP9455 Paper No.

Box PCT
Commissioner for Patents
Washington, D.C. 20231
Attn: EO/US

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the application as follows prior to examination on the merits.

IN THE CLAIMS

Please cancel claims 1-31 and add the following new claims.

CERTIFICATE OF MAILING/TRANSMISSION (37 CFR 1.8(a))

I hereby certify that this correspondence is, on the date shown below, being:

☑ deposited with the United States Postal Service with sufficient postage as Express Mail, Post Office to Addressee, Mailing Label No.: EL781402160US, addressed to Box PCT, Commissioner for Patents, Washington, DC 20231

☐ transmitted by facsimile to the Patent and Trademark Office. to Examiner ____________ at ____________

Date: 4/26/01

Joyce Krumpe
Signature
Joyce Krumpe

32. (New) Method of conditioning a received signal that contains amplitude-coded data, wherein the coding of the individual data includes a defined coding clock pulse, and wherein the received signal includes edges produced in accordance with the coding clock pulse, and wherein the received signal includes the signal of an active sensor of a vehicle wheel, comprising the following steps:

- determining, from the received signal, a time constant (t_m) set in accordance with the coding clock pulse, wherein said time constant is determined in accordance with the duration of a first pulse, and
- conditioning portions of said received signal according to the first pulse, at fixed times in accordance with the time constant (t_m),
- determining a first and a second time in accordance with the time constant (t_m), wherein the second time is set in dependence on the time of an edge determined at the first time,
- conditioning a first signal part which has a first edge at the first time,
- conditioning a second signal part at the second time, and
- detecting another edge in the received signal at a third time set in accordance with the time constant (t_m), wherein the third time is set based on an edge which has been detected as a last edge.

33. (New) Method of conditioning a received signal that contains encoded data, wherein the coding of the data includes a defined coding clock pulse, wherein the signal includes edges produced in accordance with the coding clock pulse, and the transmitted signal includes distinguishable pulses of an active sensor of a vehicle wheel, comprising the steps of:

- determining from the received signal a time constant (t_m) set in accordance with the coding clock pulse, said time constant being determined in accordance with the duration of a first pulse of said received signal, and
- conditioning parts of said received signal which include edges occurring after the first pulse,

- evaluating amplitude-coded data contained within said received signal by establishing a series of time windows which are set in accordance with the time constant (t_m),
- determining a first and a second time window within said series of time, wherein the second time window is set in dependence on the time of the edge determined at the first time,
- conditioning a first signal part that has a first edge in the first time window,
- conditioning a second signal part in the second time window, and
- detecting another edge in the received signal in a third time window set in accordance with the time constant (t_m), wherein the third time window is set based on an edge which has been detected as a last edge.

34. (New) Method as claimed in claim 33, wherein the first and second time window is opened based on a last detected edge according to a first duration (t_1) that is set in accordance with the time constant (t_m).

35. (New) Method as claimed in claim 33, wherein at least one of said first and second window is closed again in accordance with the time constant (t_m) in dependence on the time of an edge that is detected within the at least one of said first and second window.

36. (New) Method as claimed in claim 35, further including the step of:

closing at least one of said first and second time windows after a third duration (t_3) when another edge is detected after opening of at least one of said first and second time windows within a second duration (t_2) that is set in accordance with the time constant (t_m).

37. (New) Method as claimed in claim 36, wherein said first (t_1), second (t_2), and third (t_3) durations are set corresponding to the following equations:

$t_1 = t_m /2 + Dt,$

$t_2 = 3*t_m /4 - Dt,$

$t_3 = t_m /4,$

wherein:

t_m is the time constant which is equal to the coding clock pulse,

t_1 is the first duration,

t_2 is the second duration,

t_3 is the third duration, and

Dt is a fourth duration which is determined in accordance with the steepness of an edge and the time constant (t_m).

38. (New) Method as claimed in claim 37, wherein the received signal is sent by an active sensor of a vehicle wheel.

39. (New) Method as claimed in claim 38, wherein the first signal pulse is a wheel pulse which is used to determine the wheel rotational speed, and further signal pulses are data pulses having edges that facilitate the coded transfer of data, and wherein the wheel pulse is replaced by an auxiliary pulse at a transmitting end in the event of a non-rotating wheel.

40. (New) Method as claimed in claim 39, further including the step of:

detecting an error whenever no edge, more than one edge, or a wheel pulse is detected in one time window within said series of time windows.

41. (New) Method as claimed in claim 40, wherein the auxiliary pulse has an amplitude which is higher than a first threshold value and lower than a second threshold value, and the wheel pulse has an amplitude which is higher than the second threshold value, and an error is detected when a third threshold value is exceeded which is higher than the second threshold value.

42. (New) Method as claimed in claim 41, further including the step of:

determining the duration of the wheel pulse by measuring the time duration between the time the wheel pulse value exceeds the second threshold value and the time the wheel pulse value falls below the first threshold value.

43. (New) Method as claimed in claim 42, further including the step of:

when no further wheel pulse is detected within a fifth duration (t_5) that is set in accordance with the time constant (t_m) after a wheel pulse or auxiliary pulse has fallen below the first threshold value or the second threshold value, another pulse which exceeds the first threshold value but not the second threshold value is detected as auxiliary pulse.

44. (New) Method as claimed in claim 43, wherein the fifth duration (t_5) is longer than the duration which is required for the transfer of predetermined maximum number of data bits to be conditioned.

45. (New) Method as claimed in claim 42, wherein the first time window containing a first data bit is opened after the first duration (t_1) when a wheel pulse falls below the second threshold value or an auxiliary pulse falls below the first threshold value.

46. (New) Method as claimed in claim 45, wherein the conditioning of the received signal after detection of an error is interrupted until a new wheel pulse or auxiliary pulse is detected.

47. (New) Method as claimed in claim 42, wherein the third duration (t_3) is longer than the duration which the wheel pulse requires to exceed the second threshold value after exceeding of the first threshold value.

48. (New) Method as claimed in claim 33, wherein the time constant (t_m) is determined and the received signal is conditioned in real time.

49. (New) Method as claimed in claim 33, wherein the received signal is sampled at a rate set in accordance with the time constant (t_m).

50. (New) A device for conditioning a received signal that contains encoded data, said signal originating from an active sensor of a vehicle wheel, wherein the coding of the

individual data includes a defined coding clock pulse, the signal includes edges produced in accordance with the coding clock pulse and the signal includes distinguishable pulses, including an edge detection unit for detecting an edge in a time window and a time window setting unit, comprising:

- a first determining unit for determining from the received signal a time constant (t_m) set in accordance with the coding clock pulse, wherein the first determining unit determines the time constant (t_m) in accordance with the duration of the first pulse, and
- the time window setting unit for setting a first time window in accordance with the time constant (t_m) and for setting a second time window in accordance with the time constant (t_m) and in dependence on the time of an edge detected in the first time window by the edge detection unit.

51. (New) Device as claimed in claim 50, wherein said first determining unit is effective for conducting its determining function from binary data.

52. (New) Device as claimed in claim 50, further including a vehicle brake control system, coupled to said first determining unit and said time window setting unit.

53. (New) Device as claimed in claim 52, further including:

a pulse detection unit which includes a threshold value comparison unit that compares the amplitudes of the pulses with a first, a second, and a third threshold value, and the pulse detection unit detects an auxiliary pulse or data pulse when a pulse exceeds the first and not the second threshold value, detects a wheel pulse when a pulse exceeds the second and not the third threshold value, and detects an error when a pulse exceeds the third threshold value.

54. (New) Device as claimed in claim 53, wherein the first determining unit includes a first counter for defining the duration of the wheel pulse or auxiliary pulse which is started when the wheel pulse or auxiliary pulse exceeds the first threshold value, and is

possibly reset and restarted when the wheel pulse exceeds the second threshold value and is stopped when the wheel pulse or auxiliary pulse falls below the first threshold value.

55. (New) Device as claimed in claim 50, wherein the time window setting unit includes the following:

- a second determining unit for determining a first (t_1), third (t_3), and sixth duration (t_6) in accordance with the time constant (t_m),
- a first duration comparison unit which receives the first (t_1), third (t_3), and sixth duration (t_6) from the second determining unit, and
- a second counter whose output is connected to the first duration comparison unit and whose count determines closing and opening of the time window, wherein
  - = the second counter is reset and restarted when the edge detection unit has detected an edge in a time window,
  - = the time window setting unit closes a time window when the second counter has reached a first count which corresponds to the third duration (t_3),
  - = the time window setting unit opens a time window when the second counter has reached a second count which corresponds to the first duration (t_1) and is greater than the first count, and
  - = the second counter is reset and restarted when the second counter has reached a third count which corresponds to the sixth duration (t_6) and is greater than the second count.

56. (New) Device as claimed in claim 53, wherein the pulse detection unit further includes the following:

- a third counter for measuring the time that lapsed since the commencement of conditioning of a signal, which counter is reset and restarted in particular when a wheel pulse or auxiliary pulse has fallen below the first threshold value,
- a third determining unit for determining a fifth duration (t_5) in accordance with the time constant (t_m), and

- a second duration comparison unit which compares the count of the third counter with a value that corresponds to the fifth duration (t_5),

wherein when the third counter has reached the value that corresponds to the fifth duration (t_5), the pulse detection unit detects another pulse which exceeds the first but not the second threshold value as auxiliary pulse.

57. (New) Device as claimed in claim 53, further including an error detection unit for detecting an error when the edge detection unit detected no edge, a plurality of edges, or the pulse detection unit detected a wheel pulse in a time window.

58. (New) Device as claimed in claim 50, wherein a memory unit for storing the conditioned data and at least one validity bit.

59. (New) Device as claimed in claim 58, wherein the memory unit includes a validity setting unit, a data memory in which the data bits are stored, and a validity memory in which the validity bits are stored, wherein the validity setting unit sets a validity bit with a first value when the error detection unit detected no error in a time window, and sets a validity bit with a second value when the error detection unit detected an error in a time window and wherein, when errors appear when reading the parity bit, all validity bits are set with the second value.

REMARKS

Prior to a formal examination of the above-identified application, acceptance of the new claims and the enclosed substitute specification (under 37 CFR 1.125) is respectfully requested. It is believed that the substitute specification and new claims will facilitate processing of the application in accordance with M.P.E.P. 608.01(q). The substitute specification and new claims are in compliance with 37 CFR 1.52 (a and b) and, while making no substantive changes, are submitted to conform this case to the formal requirements and long-established formal standards of U.S. Patent Office practice, and to provide improved idiom and better grammatical form.

The enclosed substitute specification is presented herein in both marked-up and clean versions.

STATEMENT

The undersigned, an attorney registered to practice before the office, hereby states that the enclosed substitute specification includes the same changes as are indicated in the mark-up copy of the original specification. The substitute specification contains no new subject matter.

Respectfully submitted,

Joseph V. Coppola, Sr.
Registration No. 33,373
Rader, Fishman and Grauer PLLC
39533 Woodward Ave., Suite 140
Bloomfield Hills, Michigan 48304
(248) 594-0650
Attorney for Applicants

R0111195

SUBSTITUTE SPECIFICATION: MARKED UP COPY

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AP9455

[PC 9455]

Method and Device for Conditioning a Received Signal that Transmits Coded Data

Technical Field

The present invention generally relates to signal encoding methodologies and more particularly relates to a method and a device for conditioning a received signal that [transmits] carries with it coded data [according to the preambles of the independent claims].

Background of The Invention

Where the objective is to condition and decode a received signal which contains coded data, defined conditions must be known at the receiving end, on the basis of which coding was effected (included) at the transmitting end so that decoding is quickly and reliably possible. For example, the coding method must be known to the receiving end (e.g. edge-coded, binary, PWM, AM, FM). Because coded data are usually transmitted time-serially, certain coding methods, such as edge-coded, binary signals or in PWM (pulse width modulation), necessitate that the time base be known on the basis of which coding is carried out to permit correct decoding at the receiving end.

Publication DE 196 50 935 A1, for example, discloses the configuration of a signal that [transmits data] carries data originating at the transmitting end. This configuration is employed in vehicle manufacture, and it especially concerns the transfer of data from an active wheel sensor to a primary control unit. A system of this type is represented in Figure 1. A sensor 107, on the one hand, and a brake 108, on the other hand, are fitted to a wheel 106. Sensor 107 is an 'active' sensor which means that it not only modifies incoming electric signals (voltage or current), but also actively shapes signals to convey information from the wheel 106 to a superior unit 101. Sensor 107 is connected to unit 101 by way of line 105, and line 105 may comprise a plurality of lines. Sensor 107 transmits various pieces of information

related to wheel 106. At first information relating to the wheel rotational speed should be transmitted. In addition, other pieces of information can be transmitted such as temperature, wear of brake shoes, or similar factors. Because sensor 107 is placed in a comparatively 'rough' environment, i.e., directly on the wheel (exposed to vibrations, temperature differences, moisture), and because another requirement is to minimize the effort and structure in wiring for making the sensor less susceptible to malfunction, it is necessary to arrange the data transfer method so that it reliably functions despite the adverse conditions described hereinabove.

The system in Figure 1 includes in the control or regulation unit 101 a device 104 according to the present invention for conditioning a signal that transfers coded data; subsequent thereto is a decoding unit 103 which is connected to the device 104 by way of a line 112 that may comprise a plurality of individual lines, and thereafter a control system 102 which, in accordance with the signals received (also additional, not shown input signals) produces actuating data for the wheel concerned, on the one hand, and other data, such as alarms for alarm units 111, etc., on the other hand. The control system 102 can output e.g. electric actuating signals to a valve block 110 which, in turn, influences the wheel brake 108 by way of a hydraulic line 109.

The signal produced in the active sensor 107 and transferred to the device 104 of the present invention by way of line 105 can be configured as described in DE 196 50 935. The signal may look like shown in Figure 2. The signal produced by sensor 107 includes different pulses, i.e., a wheel pulse 201 followed by data pulses 203 with pulse pauses 202, 204 of different significance in between them. The first pulse pause 202 can be adjusted at the transmitting end and serves for a time delay before the transfer of coded data after the wheel pulse 201. The pulse pauses 204 are data pulse pauses which, exactly as the data pulses 203, indicate amplitude-coded binary data which were coded with a time clock t_p that corresponds to the ideal width of the wheel pulse 201. The data pulses 203 and data pulse pauses 204 also have the ideal width t_p. The pulse pause 202 has a width of $t_p/2$ to permit sampling of the data pulses 203 and data pulse pauses 204 in the interval of t_p after the end of a wheel pulse 201. The time ratios between wheel pulse, data pulse, and pulse pause must be known at the

receiving end so that the data can be conditioned and decoded correctly. The time base t_p is either known at the receiving end or can preferably be obtained in the conditioning operation by time measurement, e.g. measuring the pulse width.

Preferably, the wheel pulse 201 has a higher amplitude than the data pulses 203. In Figure 2, the wheel pulse 201 has an amplitude which is higher than a second threshold value SW2 and lower than a third threshold value SW3; the data pulses 203 have an amplitude which is higher than a first threshold value SW1 but lower than SW2, and the pulse pauses 202, 204 have an amplitude which is higher than a bottom threshold value SW0 but lower than SW1. The bottom threshold value SW0 lies above a zero line 205. A limited number of data pulses follows a wheel pulse. The coded data exemplarily show a bit sequence of 011001, that means, a data pulse 203 shows a logical '1' and a data pulse pause 204 shows a logical '0'. The sequence made up of a wheel pulse 201 and data pulses 203 or data pulse pauses 204 is output periodically, and the duration of the period at the transmitting end is determined in accordance with the wheel rotational speed so that following the data pulses 203 is again a wheel pulse 201 with new data pulses 203 and/or data pulse pauses 202, 204. The wheel rotational speed can then be determined from the distance between consecutive wheel pulses 201. In between consecutive wheel pulses 201, and in dependence on the interval between the wheel pulses 201, an appropriate number of data pulses 203 or data pulse pauses 204 is transmitted which permit transfer of further information such as brake lining wear, brake temperature, brake fluid temperature, or brake fluid condition, etc., from the wheel via the line 105 to the device 104 of the present invention. The shorter the interval between the consecutive wheel pulses 201 is, the fewer data pulses 203 or data pulse pauses 204 can be transmitted.

In the applicant's former application DE 198 08 575.3 entitled 'Method and device for conditioning a received signal that transmits coded data', a method and a device for conditioning data coded in the way described hereinabove is disclosed. In this application, the width t_m of a received wheel pulse, which corresponds to t_p in the optimal case, is determined as a time base, and the data pulses are subsequently sampled in regular intervals t_m. However, as the edges of the transmitted pulses are not infinitely steep, which would be ideal, but have

a finite rise (and the said rise can be different from pulse to pulse, especially from wheel pulse to wheel pulse due to environmental influences), an error in the determination of the time base may occur so that this base no longer corresponds to the width of the data pulses. This is a shortcoming in the above-mentioned former application because this error may cumulate in data conditioning so that the maximum number of data which can be conditioned reliably between two wheel pulses is limited.

The above problem was described with respect to an application in vehicle manufacture. It may occur, however, also in other applications.

An object of the present invention is to provide a method and a device for conditioning a signal that transmits coded data which permit a reliable decoding of the transmitted data and do not limit the number of data to be transmitted.

[This object is achieved by the features of the independent claims. Dependent claims are directed to preferred embodiments of the present invention.]

Before embodiments of the present invention will be described in detail, a coding method according to the present invention is explained with reference to Figure 3.

An ideal signal originating from sensor 107 can have a corresponding shape. The binary data are not amplitude-coded, but edge-coded therein. The signal includes a wheel pulse 301 and data pulses 305 with data edges 303, the width of the wheel pulse 301 in turn being t_p and the data being coded with the time clock t_p, i.e., the data edges 303 have ideally a distance of t_p one to the other. Preferably the same facts as in Figure 2 apply to the amplitudes of the pulses. Exactly as in Figure 2, the coded data show the exemplary sequence of bits of 011001, and herein a leading data edge shows a logical '1', and a trailing data edge shows a logical '0'. Of course, the edges can also show the reverse bit values or still other values. It can be seen in Figure 3 that an intermediate edge 304 is necessary when e.g. consecutive bits with the same logical value shall be transmitted because e.g. two consecutive coded trailing edges can only

be transmitted when a leading edge lies in between. The intermediate edges 304 do not carry data information and, therefore, must not be conditioned at the receiving end.

The sequence of a wheel pulse 301 and data pulses 305 is periodical as the signal sequence in Figure 2. The wheel rotational speed may then be determined from the distance between consecutive wheel pulses 301. An appropriate number of data pulses 305 with the above-mentioned information is transmitted between consecutive wheel pulses 301 in dependence on the interval between the wheel pulses 301.

In this case, too, it is necessary that time ratios between wheel pulse, data pulse and pulse pause be known at the receiving end. When the transmitter is employed in a rough environment (as described above) so that the signal edges, especially the wheel pulse edges, are differently steep due to varying environmental influences, the time clock on the basis of which coding is carried out can be determined only with insufficient accuracy at the receiving end. This is a problem. Further, the time clock itself may be exposed to variations due to the rough environment. A fixed time base cannot be assumed then. The time clock will rather vary so that it must be advised to the receiver from case to case.

According to the present invention, along with the transmitted signal an information about the time clock, also referred to as coding clock pulse, is transmitted on the basis of which coding was effected. 'Coding clock pulse' refers to the clock at which the data bits appear in succession. This need not be the working clock of a coding circuit, nor the working clock of a circuit for the conditioning of data, but can be chosen in accordance with such a circuit clock. This information relating to the coding clock pulse is determined as a time constant at the receiving end. Further conditioning of the received signal is performed in accordance with the said time constant.

In accordance with the time constant, a time or a time window is set for which or in which a first signal part which has a first edge is conditioned. Further, a second time or a second time window is set in accordance with the time constant and in dependence on the time of the first edge, for which or in which a second signal part is conditioned. A time window is a time

range where the detection of edges or, in general, signal conditioning is permitted. Another time window is respectively set based on a signal edge detected in a previous time window, and the time of the commencement and the width of the time window depends on the time constant. When another edge is detected in this time window, this edge can be taken as a new basis for another time window. One advantage involves that an edge which appears sooner or later than expected can be detected because edge detection is possible within a time range [around] which bounds the time an edge is expected. Another advantage is that the error in determining the time constant is not cumulative due to the fact that a new edge detection range is determined based on the actual time of an edge. [involves that due to the fact that adapted to the actual time of an edge a new edge detection range is determined, an error in determining the time constant cannot cumulate, with the result that the maximum] This advantage also gives rise to the additional benefit of allowing an unlimited number of data which can be conditioned with certainty between two wheel pulses is not limited.

Preferably, the transmission of the information relating to the coding clock pulse is carried out at the beginning of data transfer. The time constant also can then be established at the commencement of the conditioning operation so that the respectively latest information can be used for conditioning of the following data. In 'frequently' recurrent sequences of signals, however, a time constant obtained in an earlier cycle may also be used for a following cycle. The time constant obtained can correspond to a bit duration or, e.g., in edge-coded data to the time interval between two data edges in the received signal, or at least permit inferring therefrom that binary coding was effected, for example, by way of a proportional correlation. The time constant obtained can designate an average pulse duration or similar items in pulse width modulation.

Figure 4 illustrates one embodiment of the method according to the present invention for conditioning a received signal that transmits coded data. The signal includes pulses with real, finite steep edges. The width or duration of the wheel pulse 401 is designated as time constant t_m. In this arrangement, the width is determined as time period between the time the second threshold value SW2 is exceeded and the time when the value drops below the first threshold value SW1. However, the time constant t_m may also be fixed differently, for example, as a

time period between exceeding and dropping below the first threshold value SW1 or the second threshold value SW2, or in another fashion.

The grey ranges are time windows 403 which encompass the data edges 402 being conditioned. The bright ranges in between contain intermediate edges 404 which must not be taken into account in data conditioning because they do not carry data information. Only an edge which lies within a time window 403 may and can be detected as a data edge 402. The time window 403 must be chosen accordingly to this end.

In accordance with the time constant t_m, two durations t_1 and t_3 are determined, the first duration t_1 determining the opening of a time window 403 and the third duration t_3 determining the closing of a time window 403. An opened time window 403 will be closed after the third duration t_3, starting from an edge 402 detected in this time window 403. A next time window 403 will be opened after a first duration t_1 starting from the edge 402 detected in the previous time window 403. In this arrangement, 'opening' of a time window 403 means the beginning and 'closing' of a time window 403 means the end of a time where edge detection is allowed.

Thus, the time of detection of a data edge 402 in a time window 403 determines the time for closing of the instantaneous time window 403 and opening of the next time window 403 in which another data edge 402 is expected. It is favorable, but not imperative, that closing of the one time window and opening of the following time window 403 [founds on] <u>is based upon</u> the same edge or on the last edge detected. It is assumed that the data edges ideally have the same distance from one another because coding was effected with a fixed coding clock pulse. Accordingly, the durations t_1 and t_3 and, thus, the time windows 403 were set. The first duration t_1 must be so determined that the time window 403 will only be opened after a possible intermediate edge 404 has appeared. Further, a time window 403 must be closed before an intermediate edge 404 appears. If a data edge 402 in a time window 403 arrives too early or too late, this will not have negative effects on the detection of the following data edges 402 because the time windows 403 are set adaptively in dependence on respectively one previous data edge 402, preferably the last one detected, and are thus not determined

invariably according to a fixed time pattern. Therefore, a wrong determination of the time constant t_m will not either have great effects because this error has equal effects for each time window and will not cumulate. The fact that conditioning does not take place at defined times but at any time within a longer period of time (time window), there is the possibility of detecting also data edges which appear too early or too late, and the time window may only be chosen to be so wide that the intermediate edges 404 are not detected.

When data are not edge-coded but e.g. amplitude-coded and shall be conditioned at defined times, a point of time in accordance with the time constant t_m can be determined for data conditioning instead of the time window, and the said time is set in dependence on the time of a signal edge.

[Various embodiments of the present invention will now be explained in detail by way of the embodiments represented in the drawings. In the drawings,]

Brief Description of The Drawings

Figure 1 is an example of implementation of the present invention in the manufacture of vehicles.

Figure 2 shows an ideal signal variation as known from prior art.

Figure 3 shows an ideal signal variation according to the present invention.

Figure 4 is a view of a real signal variation according to the present invention with a schematic representation of an embodiment of the method of the present invention.

Figure 5 is a view of a real signal variation according to the present invention with a schematic representation of another embodiment of the method of the present invention.

Figure 6	is a block diagram of an embodiment of a device according to the present invention.
Figure 7	shows two time diagrams for illustration of embodiments of the present invention.
Figure 8	is a view of two real signal variations according to the present invention with a schematic representation of another embodiment of the method of the present invention.
Figure 9	is an embodiment of a circuit of the device of the present invention.
Figure 10	is a graph of a 'state machine' to carry out the present invention.

Detailed Description of The Preferred Embodiments

Figure 3 shows an ideal signal variation for edge-coded data, and the method wherein data are transmitted in an edge-coded fashion is likewise considered as the invention. The signal includes pulses, the first pulse of which is preferably a wheel pulse 301 and the further pulses are data pulses 305 with coded data edges 303 and intermediate edges 304. The data edges 303 have a distance t_p from each other, and the distance between a data edge 303 and an intermediate edge 304 preferably amounts to $t_p/2$. The first data edge 303 appears after the time t_p after the trailing edge of the wheel pulse 301. Because this data edge 303 also is a trailing edge in this case, an intermediate edge 304 is transmitted between the two trailing edges.

The signal of the present invention is preferably composed of distinguishable pulses, and the pulses are preferably current pulses, but may also be voltage pulses. The amplitude of the wheel pulse is preferably higher than the second threshold value SW2 and lower than a third threshold value SW3. This permits distinguishing the wheel pulse from the other pulses, the

amplitude of which is preferably higher than the first threshold value SW1 but lower than the second threshold value SW2. When a pulse amplitude is higher than the third threshold value SW3, it can be detected as an error [exactly as] . Likewise, when an amplitude which is lower than the bottom threshold value SW0 it can also be detected as an error condition. Thus, five amplitude ranges can be distinguished in this embodiment: a faulty range I_0 below SW0, a range I_G between SW0 and SW1, in which the signal minimum is on a level which represents the energy supply of the active sensor 107, a range $I_{H,D}$ between SW1 and SW2 in which the amplitudes of the data pulses 305 lie or those of an auxiliary pulse which will be described in detail hereinbelow, a range I_R between SW2 and SW3 for the amplitude of a wheel pulse 301 and a top faulty range I_F above SW3.

When the wheel moves very slowly or stands still, the wheel pulse 401 is replaced by an auxiliary pulse 501 as shown in Figure 5. Because an auxiliary pulse 501 preferably has almost the same amplitude as a data pulse 405, it must distinguish from the said in a different way. The maximum number A_B of data bits to be transmitted between two wheel pulses, for example, is known at the transmitting end and the receiving end. Preferably, $A_B = 9$. At the receiving end, a fifth duration t_5 may then be determined in accordance with the time constant t_m, within which the maximum number A_B of data bits are transmitted, starting from the end of a previous, preferably the last wheel pulse or auxiliary pulse. The end of a wheel pulse or auxiliary pulse can be the point where a value drops below the first threshold value SW1. Duration t_5 is then waited for until a pulse which has an amplitude in the range $I_{H,D}$ will be detected at the earliest as an auxiliary pulse 501 rather than as a data pulse 305, provided no wheel pulse 401 has meanwhile appeared. The duration t_5 can be an integral multiple n of the time constant t_m, and $n \geq A_B + 1$, preferably $n = A_B + 2$. The auxiliary pulse, too, has preferably the same width t_m as the wheel pulse 401 and can, thus, carry the information about the coding clock pulse.

An embodiment of the device 104 of the present invention is shown in Figure 6. Device 104 receives the signal pulses from the sensor 107 by way of line 105. The signal pulses can be sent to several units within the device 104. They are evaluated by a pulse detection unit 601. To this end, the pulse detection unit 601 includes a threshold value comparison unit 602

which compares the signal pulses with the threshold values SW0, SW1, SW2, and SW3 illustrated in Figure 3, for example. Depending on the result of the comparison, the pulse detection unit 601 decides whether there is a wheel pulse 401, a data pulse 405 or auxiliary pulse 501, or an error.

When the pulse detection unit 601 has detected a wheel pulse 401 or auxiliary pulse 501, a first counter 606 of a first determining unit 605 is reset and started. The first counter 606 is stopped when the wheel pulse 401 or auxiliary pulse 501 has halted below the first threshold value SW1. The first determining device 605 determines from this the time constant t_m which it submits to a time window setting unit 607 and to the pulse detection unit 601.

The time window setting unit 607 includes a second determining unit 608 which [finds out] determines the first t_1, third t_3, and a sixth duration t_6 that determine opening and closing of a time window 403, and relays corresponding values, which have been designated by t_1, t_3, and t_6 for the sake of clarity, to a first duration comparison unit 610. The count of a second counter 609 is compared with the values t_1, t_3, and t_6 in the first duration comparison unit 610. The time window setting unit 607 opens or closes a time window 403 in dependence on the result of this comparison. Details will be described hereinbelow with respect to Figure 7. The output of the time window setting unit 607 is connected to an edge detection unit 611, an error detection unit 612, and a memory unit 613 to advise to the respective units at what time a time window 403 is open.

The pulse detection unit 601 includes a third determining unit 603 which determines a duration t_5 and relays a corresponding value, which will be referred to as t_5 in the following for the sake of clarity, to a second duration comparison unit 604. The count of a third counter 617 is compared with t_5 therein. When it counted until t_5, the third counter 617 can be stopped, or can continue counting. When the count of the third counter 617 is higher than, or equal to t_5, the pulse detection unit 601 recognizes a pulse in the range $I_{H,D}$ as an auxiliary pulse 501, otherwise as a data pulse 405. The time window setting unit 607 is provided with a message from the pulse detection unit 601 when the third counter 617 has counted until t_5 so that the time window setting unit 607 will not open a new time window 403.

The count 502 of the third counter 617 is plotted against an exemplary signal variation in Figure 5.

The third counter 617 is reset and restarted when a wheel pulse 401 or auxiliary pulse 501 has dropped below the first threshold value SW1.

When the edge detection unit 611 has detected an edge in an opened window, it will relay the result to the memory unit 613 where the detected data bit is stored in a data memory 614. When an edge is detected in the time window, the edge detection unit 611 will submit a signal to the time window setting unit 607 and to the error detection unit 612. The error detection unit 612 is connected to the pulse detection unit 601 and learns e.g. from it whether a wheel pulse 401 exists. When the error detection unit 612 detects an error, it will inform the time window setting unit 607 so that the latter will not open a new time window 403. Depending on whether the error detection unit 612 detects an error in a time window, the validity setting unit 615 sets a validity bit in the validity memory 616, and e.g. a set '1'-bit can indicate a valid data bit and a set '0'-bit can indicate a faulty and, thus, invalid, data bit. By way of line 112, the data bits and validity bits can be read out and sent to a decoding unit 103 according to Figure 1.

Figure 7 shows various signal variations, related counts 701, 702 of the second counter 609 and time windows 403 according to an embodiment of the present invention. Illustrated in the top part of Figure 7 are two data edges 402a,b along with their encompassing time windows 403a,b and below is the count 701 of the second counter 609. The second counter 609 is reset and started again when a data edge 402a is detected in a time window 403a. When it has subsequently reached a value that corresponds to the third duration t_3, the time window 403a in which the data edge 402a was detected will be closed. The second counter 609 continues counting. When it has reached a value that corresponds to the first duration t_1, a new time window 403b will be opened. The second counter 609 continues counting and will not be reset until a data edge 402b is detected in the new time window 403b.

In the event that an edge appears late or not at all in an opened time window 403c, the [procedere] procedure will be as shown in the bottom part of Figure 7. A signal variation with only one data edge 402a and two time windows 403a,c and the related count 702 of the second counter 609 is illustrated therein. The second counter 609 is reset and started again when the data edge 402a is detected in the first time window 403a. The time window 403a is closed and a new time window 403c is opened depending on the respective count, as described hereinabove. The second counter 609 counts until it has reached the value that corresponds to the sixth duration t_6. Although no edge has been detected so far in the opened time window 403c, counter 609 will now be reset and restarted nevertheless. Then the time window 403c will be closed again as usual after the third duration t_3. If an edge still appears in the opened time window 403c after the reset of the second counter 609, the second counter 609 will be reset and restarted once more, and the time window 403c will be closed after another duration t_3. In other words, an edge must have been detected within a second duration t_2 after opening of a time window 403, otherwise the time window 403 will be closed again. The second duration t_2 can be determined as follows from the durations t_1, t_3, and t_6:

$$t_2 = t_6 - t_1 + t_3.$$

The durations t_1, t_3, and t_6 are preferably defined as follows:

$$t_1 = t_m /2 + Dt,$$
$$t_3 = t_m /4,$$
$$t_6 = t_m.$$

The positive fourth duration Dt is e.g. determined in dependence on the duration of the trailing edge of the wheel pulse 401 or auxiliary pulse 501 and/or the data edges 402 (leading or trailing) and/or the time constant t_m. In the optimal case, when t_m is equal to the coding clock pulse, $Dt = t_m /4$ preferably applies.

In the absence of detection of an edge in a time window 403c, the error detection unit 612 detects an error. Further potential errors which can be detected by the error detection unit 612

are illustrated in Figure 8. The time window 403d,e is respectively reviewed in Figure 8a and Figure 8b. Two edges are detected in the mentioned time window 403d in the first case in Figure 8a. The second edge may e.g. be the leading edge of a wheel pulse 401 or an intermediate edge 404 or data edge 402 of a data pulse 405. The error detection unit 612 e.g. detects an error when more than one edge is detected in a time window 403. It will then induce the validity setting unit 615 to set a validity bit which indicates a defective data bit. When the second edge detected is a leading edge of a wheel pulse 401, the said's width t_m will be determined by the first determining unit 605, whereupon new data processing can take place.

The same applies to the case illustrated in Figure 8b. In this case, only one edge is detected in the time window 403e, but this edge is the leading edge of a wheel pulse 401. This edge is detected because the wheel pulse 401 exceeds the threshold value SW2 during the opened time window 403. Therefore, the third duration t_3 is preferably longer than the time which a wheel pulse needs to exceed the second threshold value SW2 after the first threshold value SW1 is exceeded. The error detection unit 612 then detects an error, whereupon again a corresponding validity bit is set. When a parity bit (for example, as a last data bit) is sent in the data transfer as well, preferably not only the corresponding validity bit is set upon error detection of the parity bit, but all validity bits are set. The wheel pulse 401 is in turn measured by the first determining unit 605, and a new data conditioning operation for the subsequent cycle can commence.

When the error detection unit 612 detects an error, data conditioning is discontinued and all subsequent data bits are not conditioned until a wheel pulse 401 or auxiliary pulse 501 has appeared again. This is shown by the example of a non-appearing edge in a time window 403 in Figure 5. No edge is detected therein in time window 403f and, thus, the further conditioning of data is terminated in that no further time window 403 is opened. The subsequent data pulses 405 are quasi ignored.

Preferably, each data bit itself represents a single information such as brake wear or brake temperature. For example, this is a yes/no or OK/not-OK information. Thus, a logical 1 can

indicate an allowed brake temperature and a logical 0 can indicate an inadmissible brake temperature. Other information, e.g. analog signals, can be represented also by a combination of several data bits. The data bits preferably include one priority. The first data bit is the most important one which carries the most important information and should be transferred as frequently as possible, and the last data bit has the lowest priority because said indicates a less important information. Hence, it is acceptable that the rear bits are not conditioned in the event of a faulty transfer or at high wheel speeds. It is preferred that a parity bit is transmitted as the last bit. The definition of the parity bit, e.g. even or odd parity, must be agreed upon between transmitter and receiver. In a failfree transfer, data conditioning is terminated when the maximum number A_B of data bits to be conditioned was conditioned, i.e., no time window 403 will be opened until a new wheel pulse 401 or auxiliary pulse 501 has appeared.

The data memory 614 can be rated so that it can receive exactly the maximum number A_B of data bits to be conditioned, that is, preferably 9 bits. However, it can also be larger in order to store still further information bits. The validity memory 616 is preferably so designed that it contains a corresponding validity bit for each data bit. However, it could also indicate only starting from which data bit the data bits are invalid, or it could have a different design. The validity setting unit 615 will set in this case at least one validity bit, preferably, however, one validity bit for each data bit to be conditioned.

Figure 9 shows a more specific embodiment of a device according to the present invention. Among others, the concept of a 'state machine' 901 is realized in it. Before the circuit of Figure 9 is explained, the mode of operation of the state machine 901 will be explained with reference to Figure 10.

Before the arrival of either a wheel pulse 401 or an auxiliary pulse 501, the circuit is in the inactive state 1000 (State 0). It neither receives data nor takes special actions. As soon as a leading edge is detected (because the amplitude exceeds the first threshold value SW1), the circuit changes over in state 1002 (State 2) in which measuring of an auxiliary pulse 501 is started. When the second threshold value SW2 also is exceeded in the further course, transition to state 1001 (State 1) is made in which the pulse width of the wheel pulse 401 is

measured. Also, the case may occur that the pulse rise is so quick that the exceeding of the first threshold value SW1 cannot be perceived separately of the exceeding of the second threshold value SW2. Then, a direct transition from state State 0 1000 to the state State 1 1001 is made. When the value falls below the first threshold value SW1 again, transition to the state 1003 (State 3) is made in which conditioning of the received data edges 402 is started. When this operation is terminated, transition to the state State 0 1000 is made again. These state transitions consequently occur mainly in accordance with the threshold value decisions.

In Figure 9, the signal pulses are sent to the circuit by way of line 105. The signal is compared in the threshold value comparison unit 602 e.g. with the threshold values SW0, SW1, SW2 and SW3, and the four amplitude ranges or signals I_0, I_F, I_R, and $I_{H,D}$ are indicated at the output of the threshold value comparison unit 602 according to Figure 3. Thereafter, the error signals I_0 and I_F can be submitted to an arrangement for deletion of errors (not shown). The wheel signal I_R can be submitted to an arrangement for determining the wheel speed (not shown). 901 is the state machine which receives the relevant amplitude signals from the threshold value comparison unit 602 and causes activation of individual circuit components due to the variation of these signals. When a pulse passes from the amplitude range I_G to the amplitude range $I_{H,D}$ in the state State 0 1000 which can be indicated, for example, by an alternation of the signal $I_{H,D}$ from a logical '0' to a logical '1', and the output signal 906 of the third counter 502 indicates e.g. a logical '1' because the third counter has reached the count t_5, the signal State 2 e.g. passes over to logical '1', whereupon the first counter 606 is started to measure the width of the auxiliary pulse 501. The first logic 903 controls the first counter 606 and the second counter 609 e.g. by clocked operation of the two counters 606, 609 with the clock of the oscillator, and by resetting and restarting them. When the input signal reaches the amplitude range I_R as well, for example, also the signal I_R shows a logical '1' which is sent to the state machine 901. Corresponding to the transition into the state State 1 1001, the signal State 1 will then show e.g. a logical '1'. Subsequently, the first logic 903 resets the first counter 606 and starts it again in order to measure the width of the wheel pulse 401. The first counter 606 stops counting when values have fallen below the pulse range $I_{H,D}$ again and, thus, e.g. the two signals I_R and $I_{H,D}$ show a logical 0.

After measuring of an auxiliary pulse (in the state State 2) or a wheel pulse (in the state State 1) there is a transition into the state State 3 1003 and, thus, the third counter 502 is started. Conditioning of the data can now take place. The second counter 609 will be reset and restarted for the opening of the first time window 403 after detection of a wheel pulse 401 or auxiliary pulse 501 when e.g. the wheel pulse 401 drops below the second threshold value SW2 or the auxiliary pulse 501 drops below the first threshold value SW1 because it is preferred to terminate the measurement of the pulse width t_m at that moment. Subsequently, the second counter 609 is reset and restarted again when the second counter 609 has counted to t_6, and $t_6 = t_m$ in this embodiment, or when the second counter has counted at least to t_1 and an alternation of the signal $I_{H,D}$ from logical 0 to logical 1, or vice-versa, i.e., an edge in an opened time window 403, is detected in the second logic 904. The first logic 903 is informed by the output signal 905 of the second logic 904 at what time it shall reset the second counter 609.

The values t_1 and t_3 for opening and closing a time window 403 are determined in the second determining unit 608 (to which the first counter 606 forwards a value which corresponds to the time constant t_m and, for reasons of simplicity, is also referred to by t_m) and relayed to the second logic 904. The second logic 904 receives from the first counter 606 also the value t_m and compares the count of the second counter 609 with the values $t_6 = t_m$, t_1, and t_3. The sixth duration t_6 equals the time constant t_m and, therefore, need not be determined by the second determining unit 608. However, the sixth duration can also be determined as another value like in Figure 6.

The detected edge is stored as a data bit in the data memory 614, depending on the coding, and a corresponding validity bit is stored in the validity memory 616. This latter operation can e.g. be carried out after closing of a corresponding time window 403 in order that error detection can be performed while the window 403 is opened and the corresponding validity bit can be set thereafter. The data bits and validity bits can be read out by way of line 112.

The conditioning operation is carried out until e.g. the third counter 502 has counted until the duration t_5 or a new wheel pulse 401 is detected. Transition into the state State 0 1000 is made in the first case and into the state State 2 1002 in the second case.

When the data are amplitude-coded as in Figure 2, for example, it is possible that the signal is sampled at defined points of time, and these times can be chosen in dependence on the time constant t_m based on signal edges. The signal edges may e.g. be data edges, and the signal will be sampled in this case after the time t_m /2 after a data edge.

AP9455

[Abstract:]

Method and Device for Conditioning a Received Signal that Transmits Coded Data

Abstract of The Invention

The present invention relates to a method for conditioning a received signal that transmits coded data, wherein the coding of the [individual] data [is effected with] includes a defined coding clock pulse and the signal includes edges produced in accordance with the coding clock pulse, wherein from the received signal a time constant (t_m) set in accordance with the coding clock pulse is determined, a first signal part which has a first edge is conditioned at a first time that is set in accordance with the time constant (t_m) or in a first time window [(403)] that is set in accordance with the time constant (t_m), and a second signal part which has a second edge is conditioned at a second time that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge or in a second time window [(403)] that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge.

[(Figure 4)]

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AP9455

Method and Device for Conditioning a Received Signal that Transmits Coded Data

Technical Field

[0001] The present invention generally relates to signal encoding methodologies and more particularly relates to a method and a device for conditioning a received signal that carries with it coded data.

Background of The Invention

[0002] Where the objective is to condition and decode a received signal which contains coded data, defined conditions must be known at the receiving end, on the basis of which coding was effected (included) at the transmitting end so that decoding is quickly and reliably possible. For example, the coding method must be known to the receiving end (e.g. edge-coded, binary, PWM, AM, FM). Because coded data are usually transmitted time-serially, certain coding methods, such as edge-coded, binary signals or in PWM (pulse width modulation), necessitate that the time base be known on the basis of which coding is carried out to permit correct decoding at the receiving end.

[0003] Publication DE 196 50 935 A1, for example, discloses the configuration of a signal that carries data originating at the transmitting end. This configuration is employed in vehicle manufacture, and it especially concerns the transfer of data from an active wheel sensor to a primary control unit. A system of this type is represented in Figure 1. A sensor 107, on the one hand, and a brake 108, on the other hand, are fitted to a wheel 106. Sensor 107 is an 'active' sensor which means that it not only modifies incoming electric signals (voltage or current), but also actively shapes signals to convey information from the wheel 106 to a superior unit 101. Sensor 107 is connected to unit 101 by way of line 105, and line 105 may comprise a plurality of lines. Sensor 107 transmits various pieces of information related to wheel 106. At first information relating to the wheel rotational speed should be transmitted.

In addition, other pieces of information can be transmitted such as temperature, wear of brake shoes, or similar factors. Because sensor 107 is placed in a comparatively 'rough' environment, i.e., directly on the wheel (exposed to vibrations, temperature differences, moisture), and because another requirement is to minimize the effort and structure in wiring for making the sensor less susceptible to malfunction, it is necessary to arrange the data transfer method so that it reliably functions despite the adverse conditions described hereinabove.

[0004] The system in Figure 1 includes in the control or regulation unit 101 a device 104 according to the present invention for conditioning a signal that transfers coded data; subsequent thereto is a decoding unit 103 which is connected to the device 104 by way of a line 112 that may comprise a plurality of individual lines, and thereafter a control system 102 which, in accordance with the signals received (also additional, not shown input signals) produces actuating data for the wheel concerned, on the one hand, and other data, such as alarms for alarm units 111, etc., on the other hand. The control system 102 can output e.g. electric actuating signals to a valve block 110 which, in turn, influences the wheel brake 108 by way of a hydraulic line 109.

[0005] The signal produced in the active sensor 107 and transferred to the device 104 of the present invention by way of line 105 can be configured as described in DE 196 50 935. The signal may look like shown in Figure 2. The signal produced by sensor 107 includes different pulses, i.e., a wheel pulse 201 followed by data pulses 203 with pulse pauses 202, 204 of different significance in between them. The first pulse pause 202 can be adjusted at the transmitting end and serves for a time delay before the transfer of coded data after the wheel pulse 201. The pulse pauses 204 are data pulse pauses which, exactly as the data pulses 203, indicate amplitude-coded binary data which were coded with a time clock t_p that corresponds to the ideal width of the wheel pulse 201. The data pulses 203 and data pulse pauses 204 also have the ideal width t_p. The pulse pause 202 has a width of $t_p/2$ to permit sampling of the data pulses 203 and data pulse pauses 204 in the interval of t_p after the end of a wheel pulse 201. The time ratios between wheel pulse, data pulse, and pulse pause must be known at the receiving end so that the data can be conditioned and decoded correctly. The time base t_p is

either known at the receiving end or can preferably be obtained in the conditioning operation by time measurement, e.g. measuring the pulse width.

[0006] Preferably, the wheel pulse 201 has a higher amplitude than the data pulses 203. In Figure 2, the wheel pulse 201 has an amplitude which is higher than a second threshold value SW2 and lower than a third threshold value SW3; the data pulses 203 have an amplitude which is higher than a first threshold value SW1 but lower than SW2, and the pulse pauses 202, 204 have an amplitude which is higher than a bottom threshold value SW0 but lower than SW1. The bottom threshold value SW0 lies above a zero line 205. A limited number of data pulses follows a wheel pulse. The coded data exemplarily show a bit sequence of 011001, that means, a data pulse 203 shows a logical '1' and a data pulse pause 204 shows a logical '0'. The sequence made up of a wheel pulse 201 and data pulses 203 or data pulse pauses 204 is output periodically, and the duration of the period at the transmitting end is determined in accordance with the wheel rotational speed so that following the data pulses 203 is again a wheel pulse 201 with new data pulses 203 and/or data pulse pauses 202, 204. The wheel rotational speed can then be determined from the distance between consecutive wheel pulses 201. In between consecutive wheel pulses 201, and in dependence on the interval between the wheel pulses 201, an appropriate number of data pulses 203 or data pulse pauses 204 is transmitted which permit transfer of further information such as brake lining wear, brake temperature, brake fluid temperature, or brake fluid condition, etc., from the wheel via the line 105 to the device 104 of the present invention. The shorter the interval between the consecutive wheel pulses 201 is, the fewer data pulses 203 or data pulse pauses 204 can be transmitted.

[0007] In the applicant's former application DE 198 08 575.3 entitled 'Method and device for conditioning a received signal that transmits coded data', a method and a device for conditioning data coded in the way described hereinabove is disclosed. In this application, the width t_m of a received wheel pulse, which corresponds to t_p in the optimal case, is determined as a time base, and the data pulses are subsequently sampled in regular intervals t_m. However, as the edges of the transmitted pulses are not infinitely steep, which would be ideal, but have a finite rise (and the said rise can be different from pulse to pulse, especially from wheel pulse

to wheel pulse due to environmental influences), an error in the determination of the time base may occur so that this base no longer corresponds to the width of the data pulses. This is a shortcoming in the above-mentioned former application because this error may cumulate in data conditioning so that the maximum number of data which can be conditioned reliably between two wheel pulses is limited.

[0008] The above problem was described with respect to an application in vehicle manufacture. It may occur, however, also in other applications.

[0009] An object of the present invention is to provide a method and a device for conditioning a signal that transmits coded data which permit a reliable decoding of the transmitted data and do not limit the number of data to be transmitted.

[0010] Before embodiments of the present invention will be described in detail, a coding method according to the present invention is explained with reference to Figure 3.

[0011] An ideal signal originating from sensor 107 can have a corresponding shape. The binary data are not amplitude-coded, but edge-coded therein. The signal includes a wheel pulse 301 and data pulses 305 with data edges 303, the width of the wheel pulse 301 in turn being t_p and the data being coded with the time clock t_p, i.e., the data edges 303 have ideally a distance of t_p one to the other. Preferably the same facts as in Figure 2 apply to the amplitudes of the pulses. Exactly as in Figure 2, the coded data show the exemplary sequence of bits of 011001, and herein a leading data edge shows a logical '1', and a trailing data edge shows a logical '0'. Of course, the edges can also show the reverse bit values or still other values. It can be seen in Figure 3 that an intermediate edge 304 is necessary when e.g. consecutive bits with the same logical value shall be transmitted because e.g. two consecutive coded trailing edges can only be transmitted when a leading edge lies in between. The intermediate edges 304 do not carry data information and, therefore, must not be conditioned at the receiving end.

[0012] The sequence of a wheel pulse 301 and data pulses 305 is periodical as the signal sequence in Figure 2. The wheel rotational speed may then be determined from the distance between consecutive wheel pulses 301. An appropriate number of data pulses 305 with the above-mentioned information is transmitted between consecutive wheel pulses 301 in dependence on the interval between the wheel pulses 301.

[0013] In this case, too, it is necessary that time ratios between wheel pulse, data pulse and pulse pause be known at the receiving end. When the transmitter is employed in a rough environment (as described above) so that the signal edges, especially the wheel pulse edges, are differently steep due to varying environmental influences, the time clock on the basis of which coding is carried out can be determined only with insufficient accuracy at the receiving end. This is a problem. Further, the time clock itself may be exposed to variations due to the rough environment. A fixed time base cannot be assumed then. The time clock will rather vary so that it must be advised to the receiver from case to case.

[0014] According to the present invention, along with the transmitted signal an information about the time clock, also referred to as coding clock pulse, is transmitted on the basis of which coding was effected. 'Coding clock pulse' refers to the clock at which the data bits appear in succession. This need not be the working clock of a coding circuit, nor the working clock of a circuit for the conditioning of data, but can be chosen in accordance with such a circuit clock. This information relating to the coding clock pulse is determined as a time constant at the receiving end. Further conditioning of the received signal is performed in accordance with the said time constant.

[0015] In accordance with the time constant, a time or a time window is set for which or in which a first signal part which has a first edge is conditioned. Further, a second time or a second time window is set in accordance with the time constant and in dependence on the time of the first edge, for which or in which a second signal part is conditioned. A time window is a time range where the detection of edges or, in general, signal conditioning is permitted. Another time window is respectively set based on a signal edge detected in a previous time window, and the time of the commencement and the width of the time window

depends on the time constant. When another edge is detected in this time window, this edge can be taken as a new basis for another time window. One advantage involves that an edge which appears sooner or later than expected can be detected because edge detection is possible within a time range which bounds the time an edge is expected. Another advantage is that the error in determining the time constant is not cumulative due to the fact that a new edge detection range is determined based on the actual time of an edge. This advantage also gives rise to the additional benefit of allowing an unlimited number of data which can be conditioned with certainty between two wheel pulses is not limited.

[0016] Preferably, the transmission of the information relating to the coding clock pulse is carried out at the beginning of data transfer. The time constant also can then be established at the commencement of the conditioning operation so that the respectively latest information can be used for conditioning of the following data. In 'frequently' recurrent sequences of signals, however, a time constant obtained in an earlier cycle may also be used for a following cycle. The time constant obtained can correspond to a bit duration or, e.g., in edge-coded data to the time interval between two data edges in the received signal, or at least permit inferring therefrom that binary coding was effected, for example, by way of a proportional correlation. The time constant obtained can designate an average pulse duration or similar items in pulse width modulation.

[0017] Figure 4 illustrates one embodiment of the method according to the present invention for conditioning a received signal that transmits coded data. The signal includes pulses with real, finite steep edges. The width or duration of the wheel pulse 401 is designated as time constant t_m. In this arrangement, the width is determined as time period between the time the second threshold value SW2 is exceeded and the time when the value drops below the first threshold value SW1. However, the time constant t_m may also be fixed differently, for example, as a time period between exceeding and dropping below the first threshold value SW1 or the second threshold value SW2, or in another fashion.

[0018] The grey ranges are time windows 403 which encompass the data edges 402 being conditioned. The bright ranges in between contain intermediate edges 404 which must not be

taken into account in data conditioning because they do not carry data information. Only an edge which lies within a time window 403 may and can be detected as a data edge 402. The time window 403 must be chosen accordingly to this end.

[0019] In accordance with the time constant t_m, two durations t_1 and t_3 are determined, the first duration t_1 determining the opening of a time window 403 and the third duration t_3 determining the closing of a time window 403. An opened time window 403 will be closed after the third duration t_3, starting from an edge 402 detected in this time window 403. A next time window 403 will be opened after a first duration t_1 starting from the edge 402 detected in the previous time window 403. In this arrangement, 'opening' of a time window 403 means the beginning and 'closing' of a time window 403 means the end of a time where edge detection is allowed.

[0020] Thus, the time of detection of a data edge 402 in a time window 403 determines the time for closing of the instantaneous time window 403 and opening of the next time window 403 in which another data edge 402 is expected. It is favorable, but not imperative, that closing of the one time window and opening of the following time window 403 is based upon the same edge or on the last edge detected. It is assumed that the data edges ideally have the same distance from one another because coding was effected with a fixed coding clock pulse. Accordingly, the durations t_1 and t_3 and, thus, the time windows 403 were set. The first duration t_1 must be so determined that the time window 403 will only be opened after a possible intermediate edge 404 has appeared. Further, a time window 403 must be closed before an intermediate edge 404 appears. If a data edge 402 in a time window 403 arrives too early or too late, this will not have negative effects on the detection of the following data edges 402 because the time windows 403 are set adaptively in dependence on respectively one previous data edge 402, preferably the last one detected, and are thus not determined invariably according to a fixed time pattern. Therefore, a wrong determination of the time constant t_m will not either have great effects because this error has equal effects for each time window and will not cumulate. The fact that conditioning does not take place at defined times but at any time within a longer period of time (time window), there is the possibility of

detecting also data edges which appear too early or too late, and the time window may only be chosen to be so wide that the intermediate edges 404 are not detected.

[0021] When data are not edge-coded but e.g. amplitude-coded and shall be conditioned at defined times, a point of time in accordance with the time constant t_m can be determined for data conditioning instead of the time window, and the said time is set in dependence on the time of a signal edge.

Brief Description of The Drawings

[0022] Figure 1 is an example of implementation of the present invention in the manufacture of vehicles.

[0023] Figure 2 shows an ideal signal variation as known from prior art.

[0024] Figure 3 shows an ideal signal variation according to the present invention.

[0025] Figure 4 is a view of a real signal variation according to the present invention with a schematic representation of an embodiment of the method of the present invention.

[0026] Figure 5 is a view of a real signal variation according to the present invention with a schematic representation of another embodiment of the method of the present invention.

[0027] Figure 6 is a block diagram of an embodiment of a device according to the present invention.

[0028] Figure 7 shows two time diagrams for illustration of embodiments of the present invention.

[0029] Figure 8 is a view of two real signal variations according to the present invention with a schematic representation of another embodiment of the method of the present invention.

[0030] Figure 9 is an embodiment of a circuit of the device of the present invention.

[0031] Figure 10 is a graph of a 'state machine' to carry out the present invention.

Detailed Description of The Preferred Embodiments

[0032] Figure 3 shows an ideal signal variation for edge-coded data, and the method wherein data are transmitted in an edge-coded fashion is likewise considered as the invention. The signal includes pulses, the first pulse of which is preferably a wheel pulse 301 and the further pulses are data pulses 305 with coded data edges 303 and intermediate edges 304. The data edges 303 have a distance t_p from each other, and the distance between a data edge 303 and an intermediate edge 304 preferably amounts to $t_p/2$. The first data edge 303 appears after the time t_p after the trailing edge of the wheel pulse 301. Because this data edge 303 also is a trailing edge in this case, an intermediate edge 304 is transmitted between the two trailing edges.

[0033] The signal of the present invention is preferably composed of distinguishable pulses, and the pulses are preferably current pulses, but may also be voltage pulses. The amplitude of the wheel pulse is preferably higher than the second threshold value SW2 and lower than a third threshold value SW3. This permits distinguishing the wheel pulse from the other pulses, the amplitude of which is preferably higher than the first threshold value SW1 but lower than the second threshold value SW2. When a pulse amplitude is higher than the third threshold value SW3, it can be detected as an error. Likewise, when an amplitude which is lower than the bottom threshold value SW0 it can also be detected as an error condition. Thus, five amplitude ranges can be distinguished in this embodiment: a faulty range I_0 below SW0, a range I_G between SW0 and SW1, in which the signal minimum is on a level which represents the energy supply of the active sensor 107, a range $I_{H,D}$ between SW1 and SW2 in which the

amplitudes of the data pulses 305 lie or those of an auxiliary pulse which will be described in detail hereinbelow, a range I_R between SW2 and SW3 for the amplitude of a wheel pulse 301 and a top faulty range I_F above SW3.

[0034] When the wheel moves very slowly or stands still, the wheel pulse 401 is replaced by an auxiliary pulse 501 as shown in Figure 5. Because an auxiliary pulse 501 preferably has almost the same amplitude as a data pulse 405, it must distinguish from the said in a different way. The maximum number A_B of data bits to be transmitted between two wheel pulses, for example, is known at the transmitting end and the receiving end. Preferably, $A_B = 9$. At the receiving end, a fifth duration t_5 may then be determined in accordance with the time constant t_m, within which the maximum number A_B of data bits are transmitted, starting from the end of a previous, preferably the last wheel pulse or auxiliary pulse. The end of a wheel pulse or auxiliary pulse can be the point where a value drops below the first threshold value SW1. Duration t_5 is then waited for until a pulse which has an amplitude in the range $I_{H,D}$ will be detected at the earliest as an auxiliary pulse 501 rather than as a data pulse 305, provided no wheel pulse 401 has meanwhile appeared. The duration t_5 can be an integral multiple n of the time constant t_m, and $n \geq A_B + 1$, preferably $n = A_B + 2$. The auxiliary pulse, too, has preferably the same width t_m as the wheel pulse 401 and can, thus, carry the information about the coding clock pulse.

[0035] An embodiment of the device 104 of the present invention is shown in Figure 6. Device 104 receives the signal pulses from the sensor 107 by way of line 105. The signal pulses can be sent to several units within the device 104. They are evaluated by a pulse detection unit 601. To this end, the pulse detection unit 601 includes a threshold value comparison unit 602 which compares the signal pulses with the threshold values SW0, SW1, SW2, and SW3 illustrated in Figure 3, for example. Depending on the result of the comparison, the pulse detection unit 601 decides whether there is a wheel pulse 401, a data pulse 405 or auxiliary pulse 501, or an error.

[0036] When the pulse detection unit 601 has detected a wheel pulse 401 or auxiliary pulse 501, a first counter 606 of a first determining unit 605 is reset and started. The first counter

606 is stopped when the wheel pulse 401 or auxiliary pulse 501 has halted below the first threshold value SW1. The first determining device 605 determines from this the time constant t_m which it submits to a time window setting unit 607 and to the pulse detection unit 601.

[0037] The time window setting unit 607 includes a second determining unit 608 which determines the first t_1, third t_3, and a sixth duration t_6 that determine opening and closing of a time window 403, and relays corresponding values, which have been designated by t_1, t_3, and t_6 for the sake of clarity, to a first duration comparison unit 610. The count of a second counter 609 is compared with the values t_1, t_3, and t_6 in the first duration comparison unit 610. The time window setting unit 607 opens or closes a time window 403 in dependence on the result of this comparison. Details will be described hereinbelow with respect to Figure 7. The output of the time window setting unit 607 is connected to an edge detection unit 611, an error detection unit 612, and a memory unit 613 to advise to the respective units at what time a time window 403 is open.

[0038] The pulse detection unit 601 includes a third determining unit 603 which determines a duration t_5 and relays a corresponding value, which will be referred to as t_5 in the following for the sake of clarity, to a second duration comparison unit 604. The count of a third counter 617 is compared with t_5 therein. When it counted until t_5, the third counter 617 can be stopped, or can continue counting. When the count of the third counter 617 is higher than, or equal to t_5, the pulse detection unit 601 recognizes a pulse in the range $I_{H,D}$ as an auxiliary pulse 501, otherwise as a data pulse 405. The time window setting unit 607 is provided with a message from the pulse detection unit 601 when the third counter 617 has counted until t_5 so that the time window setting unit 607 will not open a new time window 403.

[0039] The count 502 of the third counter 617 is plotted against an exemplary signal variation in Figure 5.

[0040] The third counter 617 is reset and restarted when a wheel pulse 401 or auxiliary pulse 501 has dropped below the first threshold value SW1.

[0041] When the edge detection unit 611 has detected an edge in an opened window, it will relay the result to the memory unit 613 where the detected data bit is stored in a data memory 614. When an edge is detected in the time window, the edge detection unit 611 will submit a signal to the time window setting unit 607 and to the error detection unit 612. The error detection unit 612 is connected to the pulse detection unit 601 and learns e.g. from it whether a wheel pulse 401 exists. When the error detection unit 612 detects an error, it will inform the time window setting unit 607 so that the latter will not open a new time window 403. Depending on whether the error detection unit 612 detects an error in a time window, the validity setting unit 615 sets a validity bit in the validity memory 616, and e.g. a set '1'-bit can indicate a valid data bit and a set '0'-bit can indicate a faulty and, thus, invalid, data bit. By way of line 112, the data bits and validity bits can be read out and sent to a decoding unit 103 according to Figure 1.

[0042] Figure 7 shows various signal variations, related counts 701, 702 of the second counter 609 and time windows 403 according to an embodiment of the present invention. Illustrated in the top part of Figure 7 are two data edges 402a,b along with their encompassing time windows 403a,b and below is the count 701 of the second counter 609. The second counter 609 is reset and started again when a data edge 402a is detected in a time window 403a. When it has subsequently reached a value that corresponds to the third duration t_3, the time window 403a in which the data edge 402a was detected will be closed. The second counter 609 continues counting. When it has reached a value that corresponds to the first duration t_1, a new time window 403b will be opened. The second counter 609 continues counting and will not be reset until a data edge 402b is detected in the new time window 403b.

[0043] In the event that an edge appears late or not at all in an opened time window 403c, the procedure will be as shown in the bottom part of Figure 7. A signal variation with only one data edge 402a and two time windows 403a,c and the related count 702 of the second counter 609 is illustrated therein. The second counter 609 is reset and started again when the data edge 402a is detected in the first time window 403a. The time window 403a is closed and a new time window 403c is opened depending on the respective count, as described

hereinabove. The second counter 609 counts until it has reached the value that corresponds to the sixth duration t_6. Although no edge has been detected so far in the opened time window 403c, counter 609 will now be reset and restarted nevertheless. Then the time window 403c will be closed again as usual after the third duration t_3. If an edge still appears in the opened time window 403c after the reset of the second counter 609, the second counter 609 will be reset and restarted once more, and the time window 403c will be closed after another duration t_3. In other words, an edge must have been detected within a second duration t_2 after opening of a time window 403, otherwise the time window 403 will be closed again. The second duration t_2 can be determined as follows from the durations t_1, t_3, and t_6:

$$t_2 = t_6 - t_1 + t_3.$$

[0044] The durations t_1, t_3, and t_6 are preferably defined as follows:

$$t_1 = t_m /2 + Dt,$$
$$t_3 = t_m /4,$$
$$t_6 = t_m.$$

[0045] The positive fourth duration Dt is e.g. determined in dependence on the duration of the trailing edge of the wheel pulse 401 or auxiliary pulse 501 and/or the data edges 402 (leading or trailing) and/or the time constant t_m. In the optimal case, when t_m is equal to the coding clock pulse, $Dt = t_m /4$ preferably applies.

[0046] In the absence of detection of an edge in a time window 403c, the error detection unit 612 detects an error. Further potential errors which can be detected by the error detection unit 612 are illustrated in Figure 8. The time window 403d,e is respectively reviewed in Figure 8a and Figure 8b. Two edges are detected in the mentioned time window 403d in the first case in Figure 8a. The second edge may e.g. be the leading edge of a wheel pulse 401 or an intermediate edge 404 or data edge 402 of a data pulse 405. The error detection unit 612 e.g. detects an error when more than one edge is detected in a time window 403. It will then induce the validity setting unit 615 to set a validity bit which indicates a defective data bit.

When the second edge detected is a leading edge of a wheel pulse 401, the said's width t_m will be determined by the first determining unit 605, whereupon new data processing can take place.

[0047] The same applies to the case illustrated in Figure 8b. In this case, only one edge is detected in the time window 403e, but this edge is the leading edge of a wheel pulse 401. This edge is detected because the wheel pulse 401 exceeds the threshold value SW2 during the opened time window 403. Therefore, the third duration t_3 is preferably longer than the time which a wheel pulse needs to exceed the second threshold value SW2 after the first threshold value SW1 is exceeded. The error detection unit 612 then detects an error, whereupon again a corresponding validity bit is set. When a parity bit (for example, as a last data bit) is sent in the data transfer as well, preferably not only the corresponding validity bit is set upon error detection of the parity bit, but all validity bits are set. The wheel pulse 401 is in turn measured by the first determining unit 605, and a new data conditioning operation for the subsequent cycle can commence.

[0048] When the error detection unit 612 detects an error, data conditioning is discontinued and all subsequent data bits are not conditioned until a wheel pulse 401 or auxiliary pulse 501 has appeared again. This is shown by the example of a non-appearing edge in a time window 403 in Figure 5. No edge is detected therein in time window 403f and, thus, the further conditioning of data is terminated in that no further time window 403 is opened. The subsequent data pulses 405 are quasi ignored.

[0049] Preferably, each data bit itself represents a single information such as brake wear or brake temperature. For example, this is a yes/no or OK/not-OK information. Thus, a logical 1 can indicate an allowed brake temperature and a logical 0 can indicate an inadmissible brake temperature. Other information, e.g. analog signals, can be represented also by a combination of several data bits. The data bits preferably include one priority. The first data bit is the most important one which carries the most important information and should be transferred as frequently as possible, and the last data bit has the lowest priority because said indicates a less important information. Hence, it is acceptable that the rear bits are not conditioned in the

event of a faulty transfer or at high wheel speeds. It is preferred that a parity bit is transmitted as the last bit. The definition of the parity bit, e.g. even or odd parity, must be agreed upon between transmitter and receiver. In a failfree transfer, data conditioning is terminated when the maximum number A_B of data bits to be conditioned was conditioned, i.e., no time window 403 will be opened until a new wheel pulse 401 or auxiliary pulse 501 has appeared.

[0050] The data memory 614 can be rated so that it can receive exactly the maximum number A_B of data bits to be conditioned, that is, preferably 9 bits. However, it can also be larger in order to store still further information bits. The validity memory 616 is preferably so designed that it contains a corresponding validity bit for each data bit. However, it could also indicate only starting from which data bit the data bits are invalid, or it could have a different design. The validity setting unit 615 will set in this case at least one validity bit, preferably, however, one validity bit for each data bit to be conditioned.

[0051] Figure 9 shows a more specific embodiment of a device according to the present invention. Among others, the concept of a 'state machine' 901 is realized in it. Before the circuit of Figure 9 is explained, the mode of operation of the state machine 901 will be explained with reference to Figure 10.

[0052] Before the arrival of either a wheel pulse 401 or an auxiliary pulse 501, the circuit is in the inactive state 1000 (State 0). It neither receives data nor takes special actions. As soon as a leading edge is detected (because the amplitude exceeds the first threshold value SW1), the circuit changes over in state 1002 (State 2) in which measuring of an auxiliary pulse 501 is started. When the second threshold value SW2 also is exceeded in the further course, transition to state 1001 (State 1) is made in which the pulse width of the wheel pulse 401 is measured. Also, the case may occur that the pulse rise is so quick that the exceeding of the first threshold value SW1 cannot be perceived separately of the exceeding of the second threshold value SW2. Then, a direct transition from state State 0 1000 to the state State 1 1001 is made. When the value falls below the first threshold value SW1 again, transition to the state 1003 (State 3) is made in which conditioning of the received data edges 402 is started. When this operation is terminated, transition to the state State 0 1000 is made again.

These state transitions consequently occur mainly in accordance with the threshold value decisions.

[0053] In Figure 9, the signal pulses are sent to the circuit by way of line 105. The signal is compared in the threshold value comparison unit 602 e.g. with the threshold values SW0, SW1, SW2 and SW3, and the four amplitude ranges or signals I_0, I_F, I_R, and $I_{H,D}$ are indicated at the output of the threshold value comparison unit 602 according to Figure 3. Thereafter, the error signals I_0 and I_F can be submitted to an arrangement for deletion of errors (not shown). The wheel signal I_R can be submitted to an arrangement for determining the wheel speed (not shown). 901 is the state machine which receives the relevant amplitude signals from the threshold value comparison unit 602 and causes activation of individual circuit components due to the variation of these signals. When a pulse passes from the amplitude range I_G to the amplitude range $I_{H,D}$ in the state State 0 1000 which can be indicated, for example, by an alternation of the signal $I_{H,D}$ from a logical '0' to a logical '1', and the output signal 906 of the third counter 502 indicates e.g. a logical '1' because the third counter has reached the count t_5, the signal State 2 e.g. passes over to logical '1', whereupon the first counter 606 is started to measure the width of the auxiliary pulse 501. The first logic 903 controls the first counter 606 and the second counter 609 e.g. by clocked operation of the two counters 606, 609 with the clock of the oscillator, and by resetting and restarting them. When the input signal reaches the amplitude range I_R as well, for example, also the signal I_R shows a logical '1' which is sent to the state machine 901. Corresponding to the transition into the state State 1 1001, the signal State 1 will then show e.g. a logical '1'. Subsequently, the first logic 903 resets the first counter 606 and starts it again in order to measure the width of the wheel pulse 401. The first counter 606 stops counting when values have fallen below the pulse range $I_{H,D}$ again and, thus, e.g. the two signals I_R and $I_{H,D}$ show a logical 0.

[0054] After measuring of an auxiliary pulse (in the state State 2) or a wheel pulse (in the state State 1) there is a transition into the state State 3 1003 and, thus, the third counter 502 is started. Conditioning of the data can now take place. The second counter 609 will be reset and restarted for the opening of the first time window 403 after detection of a wheel pulse 401 or auxiliary pulse 501 when e.g. the wheel pulse 401 drops below the second threshold value

SW2 or the auxiliary pulse 501 drops below the first threshold value SW1 because it is preferred to terminate the measurement of the pulse width t_m at that moment. Subsequently, the second counter 609 is reset and restarted again when the second counter 609 has counted to t_6, and $t_6 = t_m$ in this embodiment, or when the second counter has counted at least to t_1 and an alternation of the signal $I_{H,D}$ from logical 0 to logical 1, or vice-versa, i.e., an edge in an opened time window 403, is detected in the second logic 904. The first logic 903 is informed by the output signal 905 of the second logic 904 at what time it shall reset the second counter 609.

[0055] The values t_1 and t_3 for opening and closing a time window 403 are determined in the second determining unit 608 (to which the first counter 606 forwards a value which corresponds to the time constant t_m and, for reasons of simplicity, is also referred to by t_m) and relayed to the second logic 904. The second logic 904 receives from the first counter 606 also the value t_m and compares the count of the second counter 609 with the values $t_6 = t_m$, t_1, and t_3. The sixth duration t_6 equals the time constant t_m and, therefore, need not be determined by the second determining unit 608. However, the sixth duration can also be determined as another value like in Figure 6.

[0056] The detected edge is stored as a data bit in the data memory 614, depending on the coding, and a corresponding validity bit is stored in the validity memory 616. This latter operation can e.g. be carried out after closing of a corresponding time window 403 in order that error detection can be performed while the window 403 is opened and the corresponding validity bit can be set thereafter. The data bits and validity bits can be read out by way of line 112.

[0057] The conditioning operation is carried out until e.g. the third counter 502 has counted until the duration t_5 or a new wheel pulse 401 is detected. Transition into the state State 0 1000 is made in the first case and into the state State 2 1002 in the second case.

[0058] When the data are amplitude-coded as in Figure 2, for example, it is possible that the signal is sampled at defined points of time, and these times can be chosen in dependence on

the time constant t_m based on signal edges. The signal edges may e.g. be data edges, and the signal will be sampled in this case after the time t_m /2 after a data edge.

AP9455

[Abstract:]

Method and Device for Conditioning a Received Signal that Transmits Coded Data

Abstract of The Invention

The present invention relates to a method for conditioning a received signal that transmits coded data, wherein the coding of the [individual] data [is effected with] includes a defined coding clock pulse and the signal includes edges produced in accordance with the coding clock pulse, wherein from the received signal a time constant (t_m) set in accordance with the coding clock pulse is determined, a first signal part which has a first edge is conditioned at a first time that is set in accordance with the time constant (t_m) or in a first time window [(403)] that is set in accordance with the time constant (t_m), and a second signal part which has a second edge is conditioned at a second time that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge or in a second time window [(403)] that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge.

[(Figure 4)]

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PC 9455

Method and Device for Conditioning a Received Signal that Transmits Coded Data

The present invention relates to a method and a device for conditioning a received signal that transmits coded data according to the preambles of the independent claims.

Where the objective is to condition and decode a received signal which contains coded data, defined conditions must be known at the receiving end, on the basis of which coding was effected at the transmitting end so that decoding is quickly and reliably possible. For example, the coding method must be known to the receiving end (e.g. edge-coded, binary, PWM, AM, FM). Because coded data are usually transmitted time-serially, certain coding methods, such as edge-coded, binary signals or in PWM (pulse width modulation), necessitate that the time base be known on the basis of which coding is carried out to permit correct decoding at the receiving end.

Publication DE 196 50 935 A1, for example, discloses the configuration of a signal that transmits data at the transmitting end. This configuration is employed in vehicle manufacture, and it especially concerns the transfer of data from an active wheel sensor to a primary control unit. A system of this type is represented in Figure 1. A sensor 107, on the one hand, and a brake 108, on the other hand, are fitted to a wheel 106. Sensor 107 is an 'active' sensor which means that it not only modifies incoming electric signals (voltage or current), but also actively shapes signals to convey information from the wheel 106 to a superior unit 101.

Sensor 107 is connected to unit 101 by way of line 105, and line 105 may comprise a plurality of lines. Sensor 107 transmits various pieces of information related to wheel 106. At first information relating to the wheel rotational speed should be transmitted. In addition, other pieces of information can be transmitted such as temperature, wear of brake shoes, or similar factors. Because sensor 107 is placed in a comparatively 'rough' environment, i.e., directly on the wheel (exposed to vibrations, temperature differences, moisture), and because another requirement is to minimize the effort and structure in wiring for making the sensor less susceptible to malfunction, it is necessary to arrange the data transfer method so that it reliably functions despite the adverse conditions described hereinabove.

The system in Figure 1 includes in the control or regulation unit 101 a device 104 according to the present invention for conditioning a signal that transfers coded data; subsequent thereto is a decoding unit 103 which is connected to the device 104 by way of a line 112 that may comprise a plurality of individual lines, and thereafter a control system 102 which, in accordance with the signals received (also additional, not shown input signals) produces actuating data for the wheel concerned, on the one hand, and other data, such as alarms for alarm units 111, etc., on the other hand. The control system 102 can output e.g. electric actuating signals to a valve block 110 which, in turn, influences the wheel brake 108 by way of a hydraulic line 109.

The signal produced in the active sensor 107 and transferred to the device 104 of the present invention by way of line 105 can be configured as described in DE 196 50 935. The signal may look like shown in Figure 2. The signal produced by sensor 107 includes different pulses, i.e., a wheel pulse 201 followed by data pulses 203 with pulse pauses 202, 204 of different significance inbetween them. The first pulse pause

202 can be adjusted at the transmitting end and serves for a time delay before the transfer of coded data after the wheel pulse 201. The pulse pauses 204 are data pulse pauses which, exactly as the data pulses 203, indicate amplitude-coded binary data which were coded with a time clock t_p that corresponds to the ideal width of the wheel pulse 201. The data pulses 203 and data pulse pauses 204 also have the ideal width t_p. The pulse pause 202 has a width of $t_p/2$ to permit sampling of the data pulses 203 and data pulse pauses 204 in the interval of t_p after the end of a wheel pulse 201. The time ratios between wheel pulse, data pulse, and pulse pause must be known at the receiving end so that the data can be conditioned and decoded correctly. The time base t_p is either known at the receiving end or can preferably be obtained in the conditioning operation by time measurement, e.g. measuring the pulse width.

Preferably, the wheel pulse 201 has a higher amplitude than the data pulses 203. In Figure 2, the wheel pulse 201 has an amplitude which is higher than a second threshold value SW2 and lower than a third threshold value SW3; the data pulses 203 have an amplitude which is higher than a first threshold value SW1 but lower than SW2, and the pulse pauses 202, 204 have an amplitude which is higher than a bottom threshold value SW0 but lower than SW1. The bottom threshold value SW0 lies above a zero line 205. A limited number of data pulses follows a wheel pulse. The coded data exemplarily show a bit sequence of 011001, that means, a data pulse 203 shows a logical '1' and a data pulse pause 204 shows a logical '0'. The sequence made up of a wheel pulse 201 and data pulses 203 or data pulse pauses 204 is output periodically, and the duration of the period at the transmitting end is determined in accordance with the wheel rotational speed so that following the data pulses 203 is again a wheel pulse 201 with new data pulses 203 and/or data pulse pauses 202, 204. The wheel rotational speed can then be determined from the

distance between consecutive wheel pulses 201. Inbetween consecutive wheel pulses 201, and in dependence on the interval between the wheel pulses 201, an appropriate number of data pulses 203 or data pulse pauses 204 is transmitted which permit transfer of further information such as brake lining wear, brake temperature, brake fluid temperature, or brake fluid condition, etc., from the wheel via the line 105 to the device 104 of the present invention. The shorter the interval between the consecutive wheel pulses 201 is, the fewer data pulses 203 or data pulse pauses 204 can be transmitted.

In the applicant's former application DE 198 08 575.3 entitled 'Method and device for conditioning a received signal that transmits coded data', a method and a device for conditioning data coded in the way described hereinabove is disclosed. In this application, the width t_m of a received wheel pulse, which corresponds to t_p in the optimal case, is determined as a time base, and the data pulses are subsequently sampled in regular intervals t_m. However, as the edges of the transmitted pulses are not infinitely steep, which would be ideal, but have a finite rise (and the said rise can be different from pulse to pulse, especially from wheel pulse to wheel pulse due to environmental influences), an error in the determination of the time base may occur so that this base no longer corresponds to the width of the data pulses. This is a shortcoming in the above-mentioned former application because this error may cumulate in data conditioning so that the maximum number of data which can be conditioned reliably between two wheel pulses is limited.

The above problem was described with respect to an application in vehicle manufacture. It may occur, however, also in other applications.

An object of the present invention is to provide a method and a device for conditioning a signal that transmits coded data which permit a reliable decoding of the transmitted data and do not limit the number of data to be transmitted.

This object is achieved by the features of the independent claims. Dependent claims are directed to preferred embodiments of the present invention.

Before embodiments of the present invention will be described in detail, a coding method according to the present invention is explained with reference to Figure 3.

An ideal signal originating from sensor 107 can have a corresponding shape. The binary data are not amplitude-coded, but edge-coded therein. The signal includes a wheel pulse 301 and data pulses 305 with data edges 303, the width of the wheel pulse 301 in turn being t_p and the data being coded with the time clock t_p, i.e., the data edges 303 have ideally a distance of t_p one to the other. Preferably the same facts as in Figure 2 apply to the amplitudes of the pulses. Exactly as in Figure 2, the coded data show the exemplary sequence of bits of 011001, and herein a leading data edge shows a logical '1', and a trailing data edge shows a logical '0'. Of course, the edges can also show the reverse bit values or still other values. It can be seen in Figure 3 that an intermediate edge 304 is necessary when e.g. consecutive bits with the same logical value shall be transmitted because e.g. two consecutive coded trailing edges can only be transmitted when a leading edge lies inbetween. The intermediate edges 304 do not carry data information and, therefore, must not be conditioned at the receiving end.

The sequence of a wheel pulse 301 and data pulses 305 is periodical as the signal sequence in Figure 2. The wheel rotational speed may then be determined from the distance

between consecutive wheel pulses 301. An appropriate number of data pulses 305 with the above-mentioned information is transmitted between consecutive wheel pulses 301 in dependence on the interval between the wheel pulses 301.

In this case, too, it is necessary that time ratios between wheel pulse, data pulse and pulse pause be known at the receiving end. When the transmitter is employed in a rough environment (as described above) so that the signal edges, especially the wheel pulse edges, are differently steep due to varying environmental influences, the time clock on the basis of which coding is carried out can be determined only with insufficient accuracy at the receiving end. This is a problem. Further, the time clock itself may be exposed to variations due to the rough environment. A fixed time base cannot be assumed then. The time clock will rather vary so that it must be advised to the receiver from case to case.

According to the present invention, along with the transmitted signal an information about the time clock, also referred to as coding clock pulse, is transmitted on the basis of which coding was effected. 'Coding clock pulse' refers to the clock at which the data bits appear in succession. This need not be the working clock of a coding circuit, nor the working clock of a circuit for the conditioning of data, but can be chosen in accordance with such a circuit clock. This information relating to the coding clock pulse is determined as a time constant at the receiving end. Further conditioning of the received signal is performed in accordance with the said time constant.

In accordance with the time constant, a time or a time window is set for which or in which a first signal part which has a first edge is conditioned. Further, a second time or a second time window is set in accordance with the time constant and in dependence on the time of the first edge, for which or in

which a second signal part is conditioned. A time window is a time range where the detection of edges or, in general, signal conditioning is permitted. Another time window is respectively set based on a signal edge detected in a previous time window, and the time of the commencement and the width of the time window depends on the time constant. When another edge is detected in this time window, this edge can be taken as a new basis for another time window. One advantage involves that an edge which appears sooner or later than expected can be detected because edge detection is possible within a time range around the time an edge is expected. Another advantage involves that due to the fact that adapted to the actual time of an edge a new edge detection range is determined, an error in determining the time constant cannot cumulate, with the result that the maximum number of data which can be conditioned with certainty between two wheel pulses is not limited.

Preferably, the transmission of the information relating to the coding clock pulse is carried out at the beginning of data transfer. The time constant also can then be established at the commencement of the conditioning operation so that the respectively latest information can be used for conditioning of the following data. In 'frequently' recurrent sequences of signals, however, a time constant obtained in an earlier cycle may also be used for a following cycle. The time constant obtained can correspond to a bit duration or, e.g., in edge-coded data to the time interval between two data edges in the received signal, or at least permit inferring therefrom that binary coding was effected, for example, by way of a proportional correlation. The time constant obtained can designate an average pulse duration or similar items in pulse width modulation.

Figure 4 illustrates one embodiment of the method according to the present invention for conditioning a received signal

that transmits coded data. The signal includes pulses with real, finite steep edges. The width or duration of the wheel pulse 401 is designated as time constant t_m. In this arrangement, the width is determined as time period between the time the second threshold value SW2 is exceeded and the time when the value drops below the first threshold value SW1. However, the time constant t_m may also be fixed differently, for example, as a time period between exceeding and dropping below the first threshold value SW1 or the second threshold value SW2, or in another fashion.

The grey ranges are time windows 403 which encompass the data edges 402 being conditioned. The bright ranges inbetween contain intermediate edges 404 which must not be taken into account in data conditioning because they do not carry data information. Only an edge which lies within a time window 403 may and can be detected as a data edge 402. The time window 403 must be chosen accordingly to this end.

In accordance with the time constant t_m, two durations t_1 and t_3 are determined, the first duration t_1 determining the opening of a time window 403 and the third duration t_3 determining the closing of a time window 403. An opened time window 403 will be closed after the third duration t_3, starting from an edge 402 detected in this time window 403. A next time window 403 will be opened after a first duration t_1 starting from the edge 402 detected in the previous time window 403. In this arrangement, 'opening' of a time window 403 means the beginning and 'closing' of a time window 403 means the end of a time where edge detection is allowed.

Thus, the time of detection of a data edge 402 in a time window 403 determines the time for closing of the instantaneous time window 403 and opening of the next time window 403 in which another data edge 402 is expected. It is favorable, but not imperative, that closing of the one time

window and opening of the following time window 403 founds on the same edge or on the last edge detected. It is assumed that the data edges ideally have the same distance from one another because coding was effected with a fixed coding clock pulse. Accordingly, the durations t_1 and t_3 and, thus, the time windows 403 were set. The first duration t_1 must be so determined that the time window 403 will only be opened after a possible intermediate edge 404 has appeared. Further, a time window 403 must be closed before an intermediate edge 404 appears. If a data edge 402 in a time window 403 arrives too early or too late, this will not have negative effects on the detection of the following data edges 402 because the time windows 403 are set adaptively in dependence on respectively one previous data edge 402, preferably the last one detected, and are thus not determined invariably according to a fixed time pattern. Therefore, a wrong determination of the time constant t_m will not either have great effects because this error has equal effects for each time window and will not cumulate. The fact that conditioning does not take place at defined times but at any time within a longer period of time (time window), there is the possibility of detecting also data edges which appear too early or too late, and the time window may only be chosen to be so wide that the intermediate edges 404 are not detected.

When data are not edge-coded but e.g. amplitude-coded and shall be conditioned at defined times, a point of time in accordance with the time constant t_m can be determined for data conditioning instead of the time window, and the said time is set in dependence on the time of a signal edge.

Various embodiments of the present invention will now be explained in detail by way of the embodiments represented in the drawings. In the drawings,

Figure 1 is an example of implementation of the present invention in the manufacture of vehicles.

Figure 2 shows an ideal signal variation as known from prior art.

Figure 3 shows an ideal signal variation according to the present invention.

Figure 4 is a view of a real signal variation according to the present invention with a schematic representation of an embodiment of the method of the present invention.

Figure 5 is a view of a real signal variation according to the present invention with a schematic representation of another embodiment of the method of the present invention.

Figure 6 is a block diagram of an embodiment of a device according to the present invention.

Figure 7 shows two time diagrams for illustration of embodiments of the present invention.

Figure 8 is a view of two real signal variations according to the present invention with a schematic representation of another embodiment of the method of the present invention.

Figure 9 is an embodiment of a circuit of the device of the present invention.

Figure 10 is a graph of a 'state machine'.

Figure 3 shows an ideal signal variation for edge-coded data, and the method wherein data are transmitted in an edge-coded fashion is likewise considered as the invention. The signal includes pulses, the first pulse of which is preferably a wheel pulse 301 and the further pulses are data pulses 305 with coded data edges 303 and intermediate edges 304. The data edges 303 have a distance t_p from each other, and the distance between a data edge 303 and an intermediate edge 304 preferably amounts to $t_p/2$. The first data edge 303 appears after the time t_p after the trailing edge of the wheel pulse 301. Because this data edge 303 also is a trailing edge in this case, an intermediate edge 304 is transmitted between the two trailing edges.

The signal of the present invention is preferably composed of distinguishable pulses, and the pulses are preferably current pulses, but may also be voltage pulses. The amplitude of the wheel pulse is preferably higher than the second threshold value SW2 and lower than a third threshold value SW3. This permits distinguishing the wheel pulse from the other pulses, the amplitude of which is preferably higher than the first threshold value SW1 but lower than the second threshold value SW2. When a pulse amplitude is higher than the third threshold value SW3, it can be detected as an error exactly as an amplitude which is lower than the bottom threshold value SW0. Thus, five amplitude ranges can be distinguished in this embodiment: a faulty range I_0 below SW0, a range I_G between SW0 and SW1, in which the signal minimum is on a level which represents the energy supply of the active sensor 107, a range $I_{H,D}$ between SW1 and SW2 in which the amplitudes of the data pulses 305 lie or those of an auxiliary pulse which will be described in detail hereinbelow, a range I_R between SW2 and SW3 for the amplitude of a wheel pulse 301 and a top faulty range I_F above SW3.

When the wheel moves very slowly or stands still, the wheel pulse 401 is replaced by an auxiliary pulse 501 as shown in Figure 5. Because an auxiliary pulse 501 preferably has almost the same amplitude as a data pulse 405, it must distinguish from the said in a different way. The maximum number A_B of data bits to be transmitted between two wheel pulses, for example, is known at the transmitting end and the receiving end. Preferably, $A_B = 9$. At the receiving end, a fifth duration t_5 may then be determined in accordance with the time constant t_m, within which the maximum number A_B of data bits are transmitted, starting from the end of a previous, preferably the last wheel pulse or auxiliary pulse. The end of a wheel pulse or auxiliary pulse can be the point where a value drops below the first threshold value SW1. Duration t_5 is then waited for until a pulse which has an amplitude in the range $I_{H,D}$ will be detected at the earliest as an auxiliary pulse 501 rather than as a data pulse 305, provided no wheel pulse 401 has meanwhile appeared. The duration t_5 can be an integral multiple n of the time constant t_m, and $n \geq A_B + 1$, preferably $n = A_B + 2$. The auxiliary pulse, too, has preferably the same width t_m as the wheel pulse 401 and can, thus, carry the information about the coding clock pulse.

An embodiment of the device 104 of the present invention is shown in Figure 6. Device 104 receives the signal pulses from the sensor 107 by way of line 105. The signal pulses can be sent to several units within the device 104. They are evaluated by a pulse detection unit 601. To this end, the pulse detection unit 601 includes a threshold value comparison unit 602 which compares the signal pulses with the threshold values SW0, SW1, SW2, and SW3 illustrated in Figure 3, for example. Depending on the result of the comparison, the pulse detection unit 601 decides whether there is a wheel

pulse 401, a data pulse 405 or auxiliary pulse 501, or an error.

When the pulse detection unit 601 has detected a wheel pulse 401 or auxiliary pulse 501, a first counter 606 of a first determining unit 605 is reset and started. The first counter 606 is stopped when the wheel pulse 401 or auxiliary pulse 501 has halted below the first threshold value SW1. The first determining device 605 determines from this the time constant t_m which it submits to a time window setting unit 607 and to the pulse detection unit 601.

The time window setting unit 607 includes a second determining unit 608 which finds out the first t_1, third t_3, and a sixth duration t_6 that determine opening and closing of a time window 403, and relays corresponding values, which have been designated by t_1, t_3, and t_6 for the sake of clarity, to a first duration comparison unit 610. The count of a second counter 609 is compared with the values t_1, t_3, and t_6 in the first duration comparison unit 610. The time window setting unit 607 opens or closes a time window 403 in dependence on the result of this comparison. Details will be described hereinbelow with respect to Figure 7. The output of the time window setting unit 607 is connected to an edge detection unit 611, an error detection unit 612, and a memory unit 613 to advise to the respective units at what time a time window 403 is open.

The pulse detection unit 601 includes a third determining unit 603 which determines a duration t_5 and relays a corresponding value, which will be referred to as t_5 in the following for the sake of clarity, to a second duration comparison unit 604. The count of a third counter 617 is compared with t_5 therein. When it counted until t_5, the third counter 617 can be stopped, or can continue counting. When the count of the third counter 617 is higher than, or equal

to t_5, the pulse detection unit 601 recognizes a pulse in the range $I_{H,D}$ as an auxiliary pulse 501, otherwise as a data pulse 405. The time window setting unit 607 is provided with a message from the pulse detection unit 601 when the third counter 617 has counted until t_5 so that the time window setting unit 607 will not open a new time window 403.

The count 502 of the third counter 617 is plotted against an exemplary signal variation in Figure 5.

The third counter 617 is reset and restarted when a wheel pulse 401 or auxiliary pulse 501 has dropped below the first threshold value SW1.

When the edge detection unit 611 has detected an edge in an opened window, it will relay the result to the memory unit 613 where the detected data bit is stored in a data memory 614. When an edge is detected in the time window, the edge detection unit 611 will submit a signal to the time window setting unit 607 and to the error detection unit 612. The error detection unit 612 is connected to the pulse detection unit 601 and learns e.g. from it whether a wheel pulse 401 exists. When the error detection unit 612 detects an error, it will inform the time window setting unit 607 so that the latter will not open a new time window 403. Depending on whether the error detection unit 612 detects an error in a time window, the validity setting unit 615 sets a validity bit in the validity memory 616, and e.g. a set '1'-bit can indicate a valid data bit and a set '0'-bit can indicate a faulty and, thus, invalid, data bit. By way of line 112, the data bits and validity bits can be read out and sent to a decoding unit 103 according to Figure 1.

Figure 7 shows various signal variations, related counts 701, 702 of the second counter 609 and time windows 403 according to an embodiment of the present invention. Illustrated in the

top part of Figure 7 are two data edges 402a,b along with their encompassing time windows 403a,b and below is the count 701 of the second counter 609. The second counter 609 is reset and started again when a data edge 402a is detected in a time window 403a. When it has subsequently reached a value that corresponds to the third duration t_3, the time window 403a in which the data edge 402a was detected will be closed. The second counter 609 continues counting. When it has reached a value that corresponds to the first duration t_1, a new time window 403b will be opened. The second counter 609 continues counting and will not be reset until a data edge 402b is detected in the new time window 403b.

In the event that an edge appears late or not at all in an opened time window 403c, the procedere will be as shown in the bottom part of Figure 7. A signal variation with only one data edge 402a and two time windows 403a,c and the related count 702 of the second counter 609 is illustrated therein. The second counter 609 is reset and started again when the data edge 402a is detected in the first time window 403a. The time window 403a is closed and a new time window 403c is opened depending on the respective count, as described hereinabove. The second counter 609 counts until it has reached the value that corresponds to the sixth duration t_6. Although no edge has been detected so far in the opened time window 403c, counter 609 will now be reset and restarted nevertheless. Then the time window 403c will be closed again as usual after the third duration t_3. If an edge still appears in the opened time window 403c after the reset of the second counter 609, the second counter 609 will be reset and restarted once more, and the time window 403c will be closed after another duration t_3. In other words, an edge must have been detected within a second duration t_2 after opening of a time window 403, otherwise the time window 403 will be closed again. The second duration t_2 can be determined as follows from the durations t_1, t_3, and t_6:

$$t_2 = t_6 - t_1 + t_3.$$

The durations t_1, t_3, and t_6 are preferably defined as follows:

$$t_1 = t_m /2 + Dt,$$
$$t_3 = t_m /4,$$
$$t_6 = t_m.$$

The positive fourth duration Dt is e.g. determined in dependence on the duration of the trailing edge of the wheel pulse 401 or auxiliary pulse 501 and/or the data edges 402 (leading or trailing) and/or the time constant t_m. In the optimal case, when t_m is equal to the coding clock pulse, Dt = t_m /4 preferably applies.

In the absence of detection of an edge in a time window 403c, the error detection unit 612 detects an error. Further potential errors which can be detected by the error detection unit 612 are illustrated in Figure 8. The time window 403d,e is respectively reviewed in Figure 8a and Figure 8b. Two edges are detected in the mentioned time window 403d in the first case in Figure 8a. The second edge may e.g. be the leading edge of a wheel pulse 401 or an intermediate edge 404 or data edge 402 of a data pulse 405. The error detection unit 612 e.g. detects an error when more than one edge is detected in a time window 403. It will then induce the validity setting unit 615 to set a validity bit which indicates a defective data bit. When the second edge detected is a leading edge of a wheel pulse 401, the said's width t_m will be determined by the first determining unit 605, whereupon new data processing can take place.

The same applies to the case illustrated in Figure 8b. In this case, only one edge is detected in the time window 403e,

but this edge is the leading edge of a wheel pulse 401. This edge is detected because the wheel pulse 401 exceeds the threshold value SW2 during the opened time window 403. Therefore, the third duration t_3 is preferably longer than the time which a wheel pulse needs to exceed the second threshold value SW2 after the first threshold value SW1 is exceeded. The error detection unit 612 then detects an error, whereupon again a corresponding validity bit is set. When a parity bit (for example, as a last data bit) is sent in the data transfer as well, preferably not only the corresponding validity bit is set upon error detection of the parity bit, but all validity bits are set. The wheel pulse 401 is in turn measured by the first determining unit 605, and a new data conditioning operation for the subsequent cycle can commence.

When the error detection unit 612 detects an error, data conditioning is discontinued and all subsequent data bits are not conditioned until a wheel pulse 401 or auxiliary pulse 501 has appeared again. This is shown by the example of a non-appearing edge in a time window 403 in Figure 5. No edge is detected therein in time window 403f and, thus, the further conditioning of data is terminated in that no further time window 403 is opened. The subsequent data pulses 405 are quasi ignored.

Preferably, each data bit itself represents a single information such as brake wear or brake temperature. For example, this is a yes/no or OK/not-OK information. Thus, a logical 1 can indicate an allowed brake temperature and a logical 0 can indicate an inadmissible brake temperature. Other information, e.g. analog signals, can be represented also by a combination of several data bits. The data bits preferably include one priority. The first data bit is the most important one which carries the most important information and should be transferred as frequently as possible, and the last data bit has the lowest priority

because said indicates a less important information. Hence, it is acceptable that the rear bits are not conditioned in the event of a faulty transfer or at high wheel speeds. It is preferred that a parity bit is transmitted as the last bit. The definition of the parity bit, e.g. even or odd parity, must be agreed upon between transmitter and receiver. In a failfree transfer, data conditioning is terminated when the maximum number A_B of data bits to be conditioned was conditioned, i.e., no time window 403 will be opened until a new wheel pulse 401 or auxiliary pulse 501 has appeared.

The data memory 614 can be rated so that it can receive exactly the maximum number A_B of data bits to be conditioned, that is, preferably 9 bits. However, it can also be larger in order to store still further information bits. The validity memory 616 is preferably so designed that it contains a corresponding validity bit for each data bit. However, it could also indicate only starting from which data bit the data bits are invalid, or it could have a different design. The validity setting unit 615 will set in this case at least one validity bit, preferably, however, one validity bit for each data bit to be conditioned.

Figure 9 shows a more specific embodiment of a device according to the present invention. Among others, the concept of a 'state machine' 901 is realized in it. Before the circuit of Figure 9 is explained, the mode of operation of the state machine 901 will be explained with reference to Figure 10.

Before the arrival of either a wheel pulse 401 or an auxiliary pulse 501, the circuit is in the inactive state 1000 (State 0). It neither receives data nor takes special actions. As soon as a leading edge is detected (because the amplitude exceeds the first threshold value SW1), the circuit changes over in state 1002 (State 2) in which measuring of an

auxiliary pulse 501 is started. When the second threshold value SW2 also is exceeded in the further course, transition to state 1001 (State 1) is made in which the pulse width of the wheel pulse 401 is measured. Also, the case may occur that the pulse rise is so quick that the exceeding of the first threshold value SW1 cannot be perceived separately of the exceeding of the second threshold value SW2. Then, a direct transition from state State 0 1000 to the state State 1 1001 is made. When the value falls below the first threshold value SW1 again, transition to the state 1003 (State 3) is made in which conditioning of the received data edges 402 is started. When this operation is terminated, transition to the state State 0 1000 is made again. These state transitions consequently occur mainly in accordance with the threshold value decisions.

In Figure 9, the signal pulses are sent to the circuit by way of line 105. The signal is compared in the threshold value comparison unit 602 e.g. with the threshold values SW0, SW1, SW2 and SW3, and the four amplitude ranges or signals I_0, I_F, I_R, and $I_{H,D}$ are indicated at the output of the threshold value comparison unit 602 according to Figure 3. Thereafter, the error signals I_0 and I_F can be submitted to an arrangement for deletion of errors (not shown). The wheel signal I_R can be submitted to an arrangement for determining the wheel speed (not shown). 901 is the state machine which receives the relevant amplitude signals from the threshold value comparison unit 602 and causes activation of individual circuit components due to the variation of these signals. When a pulse passes from the amplitude range I_G to the amplitude range $I_{H,D}$ in the state State 0 1000 which can be indicated, for example, by an alternation of the signal $I_{H,D}$ from a logical '0' to a logical '1', and the output signal 906 of the third counter 502 indicates e.g. a logical '1' because the third counter has reached the count t_5, the signal State 2 e.g. passes over to logical '1', whereupon the

first counter 606 is started to measure the width of the auxiliary pulse 501. The first logic 903 controls the first counter 606 and the second counter 609 e.g. by clocked operation of the two counters 606, 609 with the clock of the oscillator, and by resetting and restarting them. When the input signal reaches the amplitude range I_R as well, for example, also the signal I_R shows a logical '1' which is sent to the state machine 901. Corresponding to the transition into the state State 1 1001, the signal State 1 will then show e.g. a logical '1'. Subsequently, the first logic 903 resets the first counter 606 and starts it again in order to measure the width of the wheel pulse 401. The first counter 606 stops counting when values have fallen below the pulse range $I_{H,D}$ again and, thus, e.g. the two signals I_R and $I_{H,D}$ show a logical 0.

After measuring of an auxiliary pulse (in the state State 2) or a wheel pulse (in the state State 1) there is a transition into the state State 3 1003 and, thus, the third counter 502 is started. Conditioning of the data can now take place. The second counter 609 will be reset and restarted for the opening of the first time window 403 after detection of a wheel pulse 401 or auxiliary pulse 501 when e.g. the wheel pulse 401 drops below the second threshold value SW2 or the auxiliary pulse 501 drops below the first threshold value SW1 because it is preferred to terminate the measurement of the pulse width t_m at that moment. Subsequently, the second counter 609 is reset and restarted again when the second counter 609 has counted to t_6, and $t_6 = t_m$ in this embodiment, or when the second counter has counted at least to t_1 and an alternation of the signal $I_{H,D}$ from logical 0 to logical 1, or vice-versa, i.e., an edge in an opened time window 403, is detected in the second logic 904. The first logic 903 is informed by the output signal 905 of the second logic 904 at what time it shall reset the second counter 609.

The values t_1 and t_3 for opening and closing a time window 403 are determined in the second determining unit 608 (to which the first counter 606 forwards a value which corresponds to the time constant t_m and, for reasons of simplicity, is also referred to by t_m) and relayed to the second logic 904. The second logic 904 receives from the first counter 606 also the value t_m and compares the count of the second counter 609 with the values $t_6 = t_m$, t_1, and t_3. The sixth duration t_6 equals the time constant t_m and, therefore, need not be determined by the second determining unit 608. However, the sixth duration can also be determined as another value like in Figure 6.

The detected edge is stored as a data bit in the data memory 614, depending on the coding, and a corresponding validity bit is stored in the validity memory 616. This latter operation can e.g. be carried out after closing of a corresponding time window 403 in order that error detection can be performed while the window 403 is opened and the corresponding validity bit can be set thereafter. The data bits and validity bits can be read out by way of line 112.

The conditioning operation is carried out until e.g. the third counter 502 has counted until the duration t_5 or a new wheel pulse 401 is detected. Transition into the state State 0 1000 is made in the first case and into the state State 2 1002 in the second case.

When the data are amplitude-coded as in Figure 2, for example, it is possible that the signal is sampled at defined points of time, and these times can be chosen in dependence on the time constant t_m based on signal edges. The signal edges may e.g. be data edges, and the signal will be sampled in this case after the time t_m /2 after a data edge.

Patent Claims:

1. Method of conditioning a received signal that transmits coded data, wherein the coding of the individual data is effected with a defined coding clock pulse and the signal includes edges produced in accordance with the coding clock pulse,
   c h a r a c t e r i z e d by the following steps:

   - determining from the received signal a time constant (t_m) set in accordance with the coding clock pulse,

   - conditioning a first signal part which has a first edge at a first time that is set in accordance with the time constant (t_m) or in a first time window (403) that is set in accordance with the time constant (t_m), and

   - conditioning a second signal part at a second time that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge or in a second time window (403) that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge.

2. Method as claimed in claim 1,
   c h a r a c t e r i z e d in that the data are discrete, preferably binary data.

3. Method as claimed in claim 2,
   c h a r a c t e r i z e d in that the data are edge-coded and another edge is detected in the received signal in a time window (403) that is set in accordance

with the time constant (t_m) based on an edge which has been detected before, especially as the last edge.

4. Method as claimed in claim 3, c h a r a c t e r i z e d in that the transmitted signal includes distinguishable pulses, and the time constant (t_m) is determined in accordance with the duration of a pulse, especially the first pulse.

5. Method as claimed in claim 3 or 4, c h a r a c t e r i z e d in that the time window (403) is opened based on the last detected edge according to a first duration (t_1) that is set in accordance with the time constant (t_m).

6. Method as claimed in any one of claims 3 to 5, c h a r a c t e r i z e d in that the opened window is closed again in accordance with the time constant (t_m) and especially in dependence on the time of an edge that is possibly detected in the opened window.

7. Method as claimed in claim 6, c h a r a c t e r i z e d in that

- when another edge is detected after opening of the time window (403) within a second duration (t_2) that is set in accordance with the time constant (t_m), the time window (403) will be closed after a third duration (t_3) that is set in accordance with the time constant (t_m) after the further edge is detected, or

- when no further edge is detected within the second duration (t_2) after opening of the time window (403), the window will be closed at the end of the second duration (t_2).

8. Method as claimed in claim 7, c h a r a c t e r i z e d in that the durations are set corresponding to one or more of the following equations:

$$t_1 = t_m /2 + Dt,$$
$$t_2 = 3.t_m /4 - Dt,$$
$$t_3 = t_m /4,$$

wherein t_m is the time constant which is equal to the coding clock pulse, t_1 is the first duration, t_2 is the second duration, t_3 is the third duration, and Dt is a fourth duration which is determined in accordance with the steepness of an edge and the time constant (t_m).

9. Method as claimed in any one of claims 4 to 8, c h a r a c t e r i z e d in that the transmitted signal is sent by an active sensor (107) of a vehicle wheel (106).

10. Method as claimed in claim 9, c h a r a c t e r i z e d in that the signal includes one or more of the following features:

- the first signal pulse is a wheel pulse (401) which is used to determine the wheel rotational speed, and further signal pulses are data pulses (405) whose edges (402) serve for the coded transfer of data, and the said wheel pulse (401) is replaced by an auxiliary pulse (501) at the transmitting end in the event of wheel standstill,

- the auxiliary pulse (501) and the wheel pulse (401) have a different amplitude and an essentially equal duration,

- the data pulses (405) and the wheel pulse (401) have a different amplitude,

- the auxiliary pulse (501) and the data pulse (405) have a substantially equal amplitude.

11. Method as claimed in claim 10, c h a r a c t e r i z e d in that an error is detected in case no edge, more than one edge, or a wheel pulse (401) is detected in the time window (403), and conditioning of the signal is terminated as a result.

12. Method as claimed in claim 10 or 11, c h a r a c t e r i z e d in that the auxiliary pulse (501) has an amplitude which is higher than a first threshold value (SW1) and lower than a second threshold value (SW2), and the wheel pulse (401) has an amplitude which is higher than the second threshold value (SW2), and an error is detected when a third threshold value (SW3) is exceeded which is higher than the second threshold value (SW2).

13. Method as claimed in claim 12, c h a r a c t e r i z e d in that for determining the duration of the wheel pulse (401), the time measurement is started when the second threshold value (SW2) is exceeded and terminated when the value falls below the first threshold value (SW1), and wherein for determining the duration of the auxiliary pulse (501) the time measurement is started when the first threshold value (SW1) is exceeded and terminated when the value falls below the first threshold value (SW1).

14. Method as claimed in any one of claims 10 to 13 and 12, characterized in that when no further wheel pulse (401) is detected within a fifth duration (t_5) that is set in accordance with the time constant (t_m) after a wheel pulse (401) or auxiliary pulse (501) has fallen below the first threshold value (SW1) or the second threshold value (SW2), another pulse which exceeds the first threshold value (SW1) but not the second threshold value (SW2) is detected as auxiliary pulse (501).

15. Method as claimed in claim 14, characterized in that the fifth duration (t_5) is longer than the duration which is required for the transfer of the given maximum number (A_B) of data bits to be conditioned.

16. Method as claimed in any one of claims 12 to 15 and 5, characterized in that the time window (403) for the first data bit is opened after the first duration (t_1) when a wheel pulse (401) falls below the second threshold value (SW2) or an auxiliary pulse (501) falls below the first threshold value (SW1).

17. Method as claimed in any one of claims 12 to 16, characterized in that the conditioning of the signal after detection of an error is interrupted until a new wheel pulse (401) or auxiliary pulse (501) is detected.

18. Method as claimed in claims 8 and 12, characterized in that the third duration (t_3) is longer than the duration which the wheel pulse (401) requires to exceed the second threshold value (SW2) after exceeding of the first threshold value (SW1).

19. Method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the time constant (t_m) is determined and the received signal is conditioned in real time.

20. Method as claimed in claim 2, c h a r a c t e r i z e d in that the data are amplitude-coded and the received signal is sampled at a time set in accordance with the time constant (t_m) and based on an edge detected before, especially as the last edge.

21. Device (104) for conditioning a received signal that transmits coded data, wherein the coding of the individual data is effected with a defined coding clock pulse and the signal includes edges produced in accordance with the coding clock pulse, especially for implementing the method as claimed in any one of claims 1 to 19,
c h a r a c t e r i z e d by

- a first determining unit (605) for determining from the received signal a time constant (t_m) set in accordance with the coding clock pulse,

- an edge detection unit (611) for detecting an edge in a time window (403), and

- a time window setting unit (607) for setting a first time window (403) in accordance with the time constant (t_m) and for setting a second time window (403) in accordance with the time constant (t_m) and in dependence on the time of an edge detected in the first time window (403) by the edge detection unit (611).

22. Device (104) as claimed in claim 21, c h a r a c t e r i z e d in that it is designed for the output of discrete, preferably binary data.

23. Device (104) as claimed in claim 22, c h a r a c t e r i z e d in that the transmitted signal includes distinguishable pulses, and the first determining unit (605) determines the time constant (t_m) in accordance with the duration of a pulse, especially the first pulse.

24. Device (104) as claimed in claim 23, c h a r a c t e r i z e d in that the device is a part of a vehicle brake control system (101) and designed to receive signals of an active sensor (107) of a vehicle wheel (106).

25. Device (104) as claimed in claim 23 or 24 for implementing the method as claimed in claim 10, c h a r a c t e r i z e d by a pulse detection unit (601) which includes a threshold value comparison unit (602) that compares the amplitudes of the pulses with a first (SW1), a second (SW2), and a third threshold value (SW3), and the pulse detection unit (602) detects an auxiliary pulse (501) or data pulse (405) when a pulse exceeds the first (SW1) and not the second threshold value (SW2), detects a wheel pulse (401) when a pulse exceeds the second (SW2) and not the third threshold value (SW3), and detects an error when a pulse exceeds the third threshold value (SW3).

26. Device (104) as claimed in claim 25, c h a r a c t e r i z e d in that the first determining unit (605) includes a first counter (606) for defining the duration of the wheel pulse (401) or

auxiliary pulse (501) which is started when the wheel pulse (401) or auxiliary pulse 501) exceeds the first threshold value (SW1), and is possibly reset and restarted when the wheel pulse (401) exceeds the second threshold value (SW2) and is stopped when the wheel pulse (401) or auxiliary pulse (501) falls below the first threshold value (SW1).

27. Device (104) as claimed in any one of the claims 23 to 26,
c h a r a c t e r i z e d in that the time window setting unit (607) includes the following:

- a second determining unit (608) for determining a first (t_1), third (t_3), and sixth duration (t_6) in accordance with the time constant (t_m),

- a first duration comparison unit (610) which receives the first (t_1), third (t_3), and sixth duration (t_6) from the second determining unit (608), and

- a second counter (609) whose output is connected to the first duration comparison unit (610) and whose count determines closing and opening of the time window (403), wherein

  the second counter (609) is reset and restarted when the edge detection unit (611) has detected an edge in a time window (403),

  the time window setting unit (607) closes a time window (403) when the second counter (609) has reached a first count which corresponds to the third duration (t_3),

the time window setting unit opens a time window (403) when the second counter (609) has reached a second count which corresponds to the first duration (t_1) and is greater than the first count, and

the second counter (609) is reset and restarted when the second counter (609) has reached a third count which corresponds to the sixth duration (t_6) and is greater than the second count.

28. Device (104) as claimed in any one of claims 23 to 27, c h a r a c t e r i z e d in that the pulse detection unit (601) includes the following:

- a third counter (617) for measuring the time that lapsed since the commencement of conditioning of a signal, which counter is reset and restarted in particular when a wheel pulse (401) or auxiliary pulse (501) has fallen below the first threshold value (SW1),

- a third determining unit (603) for determining a fifth duration (t_5) in accordance with the time constant (t_m), and

- a second duration comparison unit (604) which compares the count of the third counter (617) with a value that corresponds to the fifth duration (t_5),

wherein when the third counter (617) has reached the value that corresponds to the fifth duration (t_5), the pulse detection unit (601) detects another pulse which exceeds the first (SW1) but not the second threshold value (SW2) as auxiliary pulse (501).

29. Device (104) as claimed in any one of claims 25 to 29, c h a r a c t e r i z e d by an error detection unit (612) which detects an error when the edge detection unit (611) detected no edge or several edges or the pulse detection unit (601) detected a wheel pulse (401) in a time window (403), and terminates the conditioning of the signal as a result.

30. Device (104) as claimed in any one of claims 22 to 30, c h a r a c t e r i z e d by a memory unit (613) for storing the conditioned data bits and at least one validity bit.

31. Device (104) as claimed in claim 31, c h a r a c t e r i z e d in that the memory unit (613) includes a validity setting unit (615), a data memory (614) in which the data bits are stored, and a validity memory (616) in which the validity bits are stored, wherein the validity setting unit (615) sets a validity bit with a first value when the error detection unit (612) detected no error in a time window (403), and sets a validity bit with a second value when the error detection unit (612) detected an error in a time window (403) and wherein, when errors appear when reading the parity bit, all validity bits are set with the second value.

Abstract:

Method and Device for Conditioning a Received Signal that Transmits Coded Data

The present invention relates to a method for conditioning a received signal that transmits coded data, wherein the coding of the individual data is effected with a defined coding clock pulse and the signal includes edges produced in accordance with the coding clock pulse, wherein from the received signal a time constant (t_m) set in accordance with the coding clock pulse is determined, a first signal part which has a first edge is conditioned at a first time that is set in accordance with the time constant (t_m) or in a first time window (403) that is set in accordance with the time constant (t_m), and a second signal part which has a second edge is conditioned at a second time that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge or in a second time window (403) that is set in accordance with the time constant (t_m) and in dependence on the time of the first edge.

(Figure 4)

Fig. 1

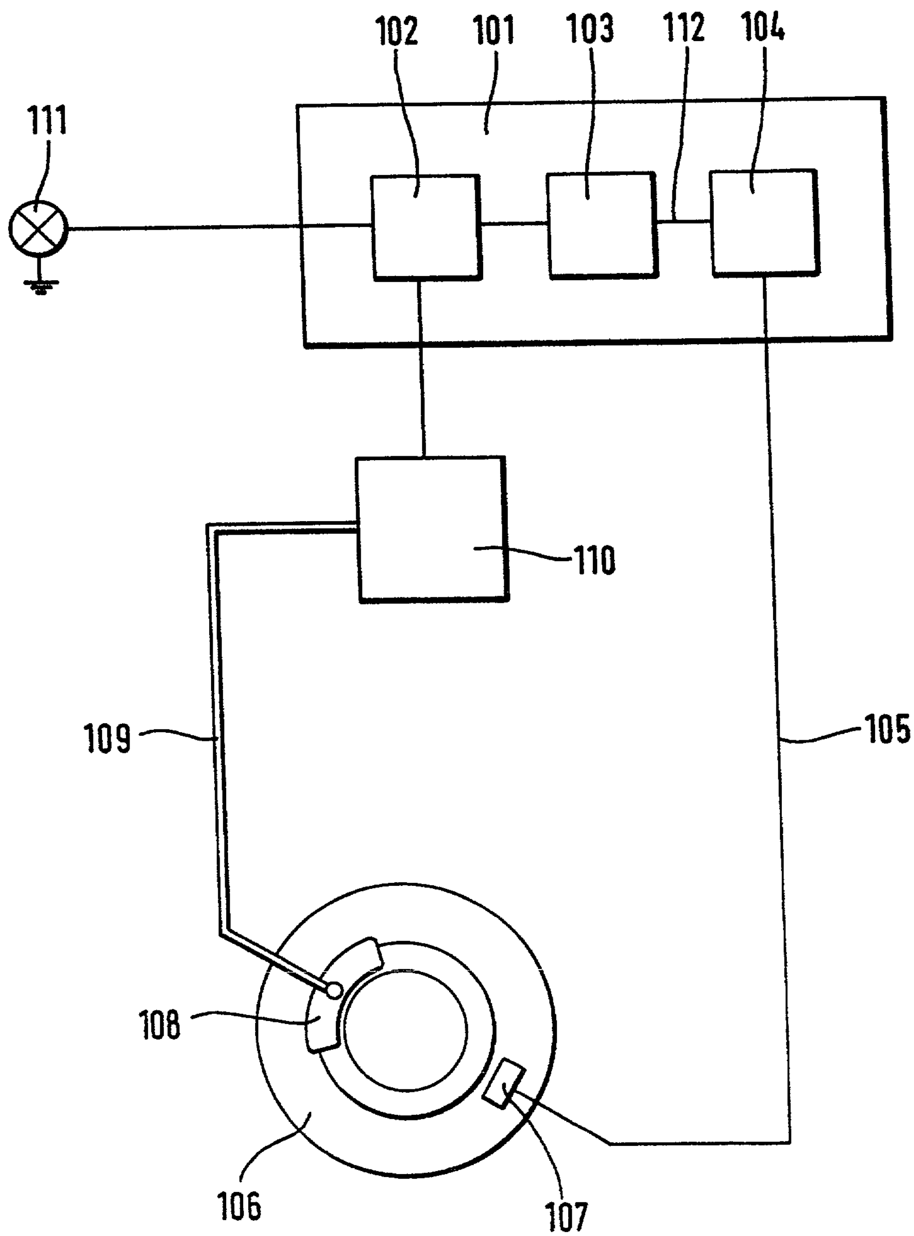


Fig. 2

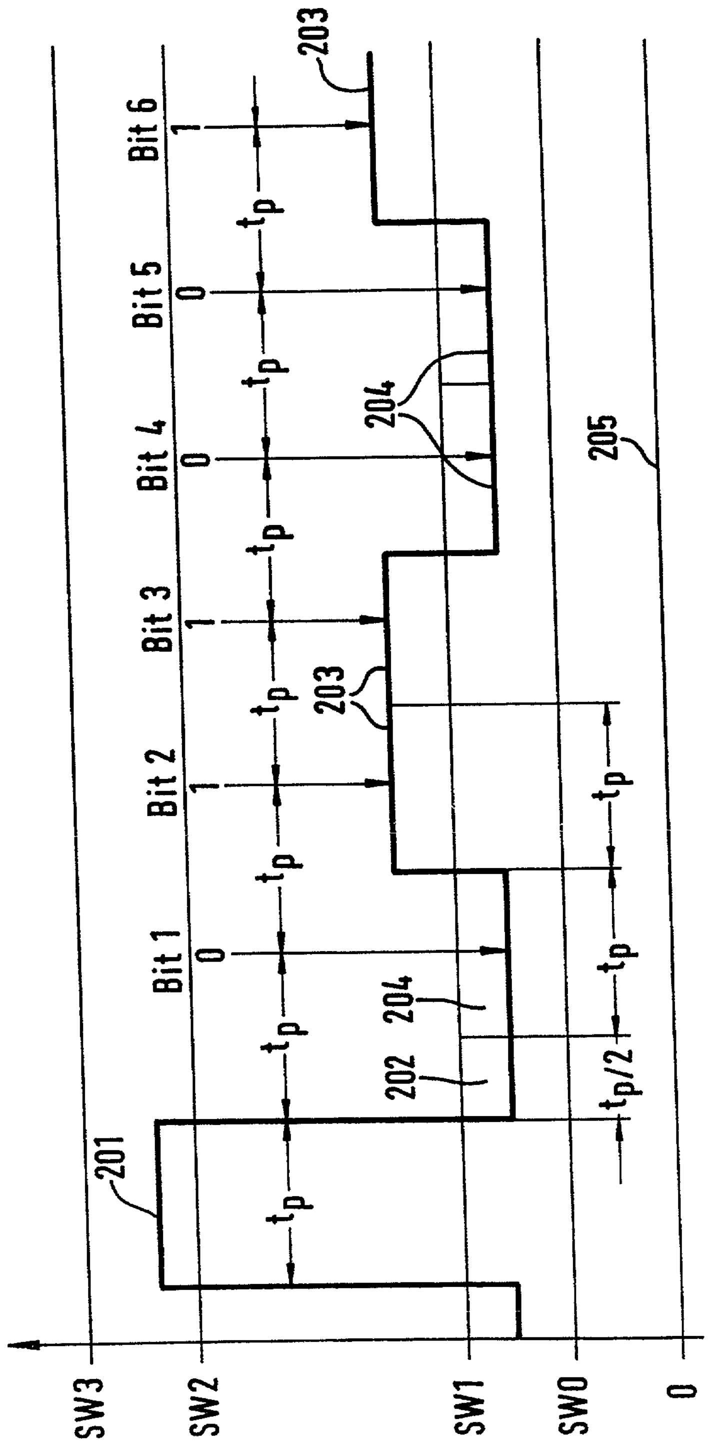

SW3
SW2
SW1
SW0
0
Bit 1
Bit 2
Bit 3
Bit 4
Bit 5
Bit 6
0
1
1
0
0
1
t_p
$t_p/2$
201
202
203
204
205

Fig. 3

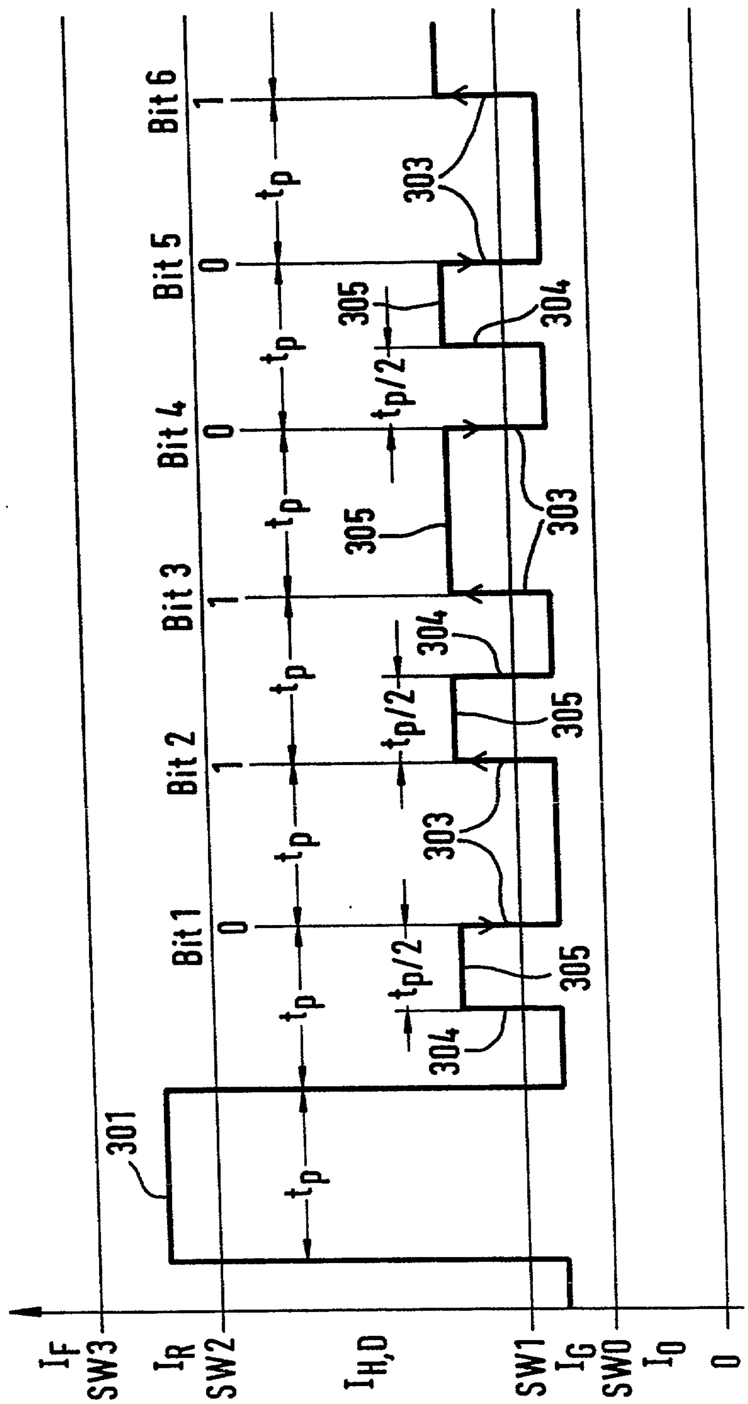
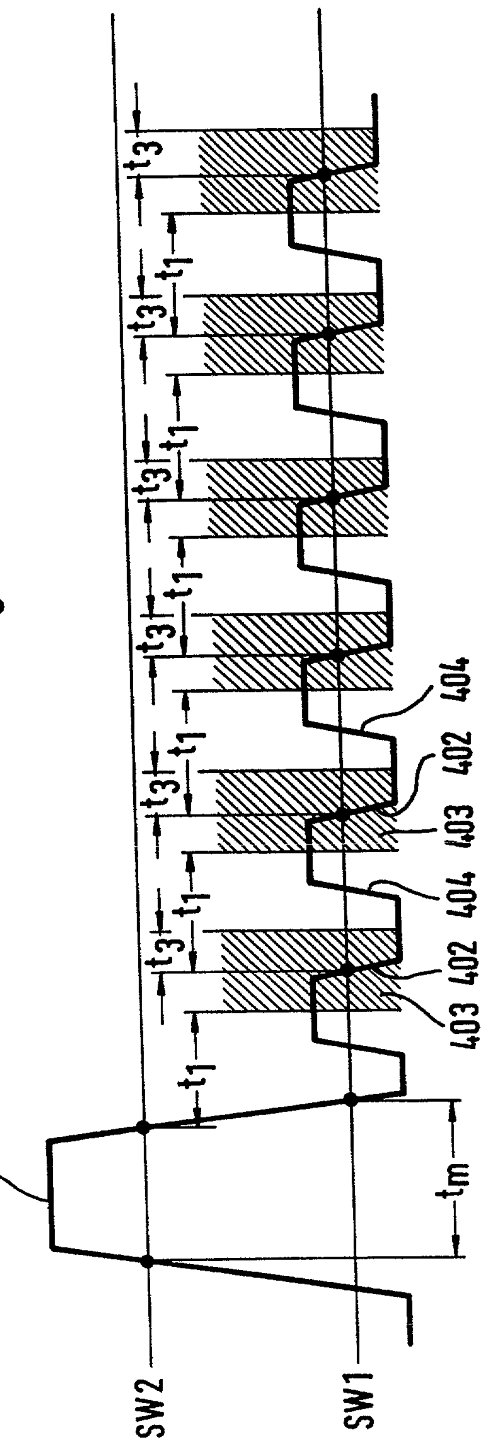

Bit 1
Bit 2
Bit 3
Bit 4
Bit 5
Bit 6
0
1
1
0
0
1
t_p
$t_p/2$
301
303
304
305
I_F
SW3
I_R
SW2
$I_{H,D}$
SW1
I_G
SW0
I_0
0

Fig. 4



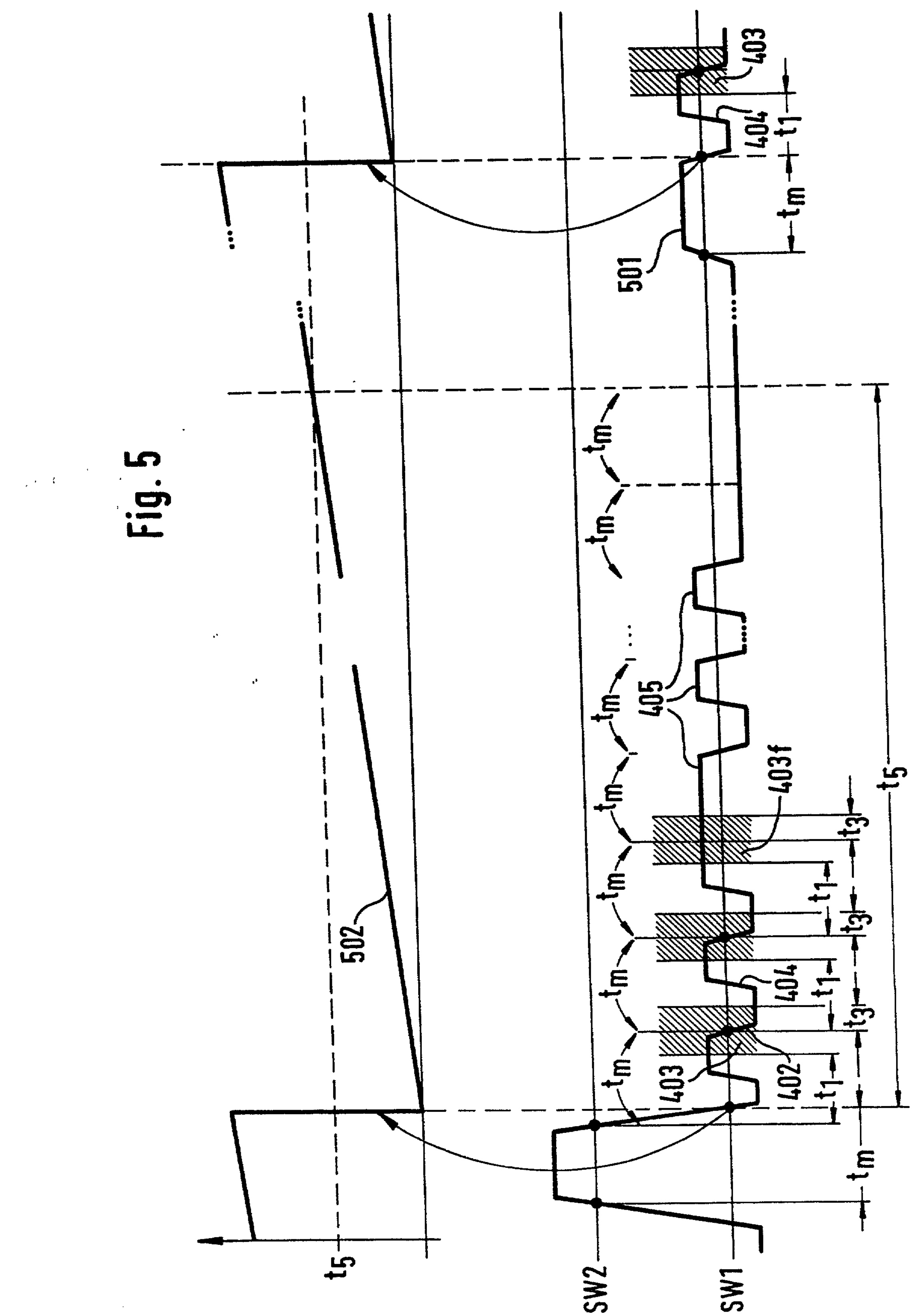


Fig. 5

Fig. 6

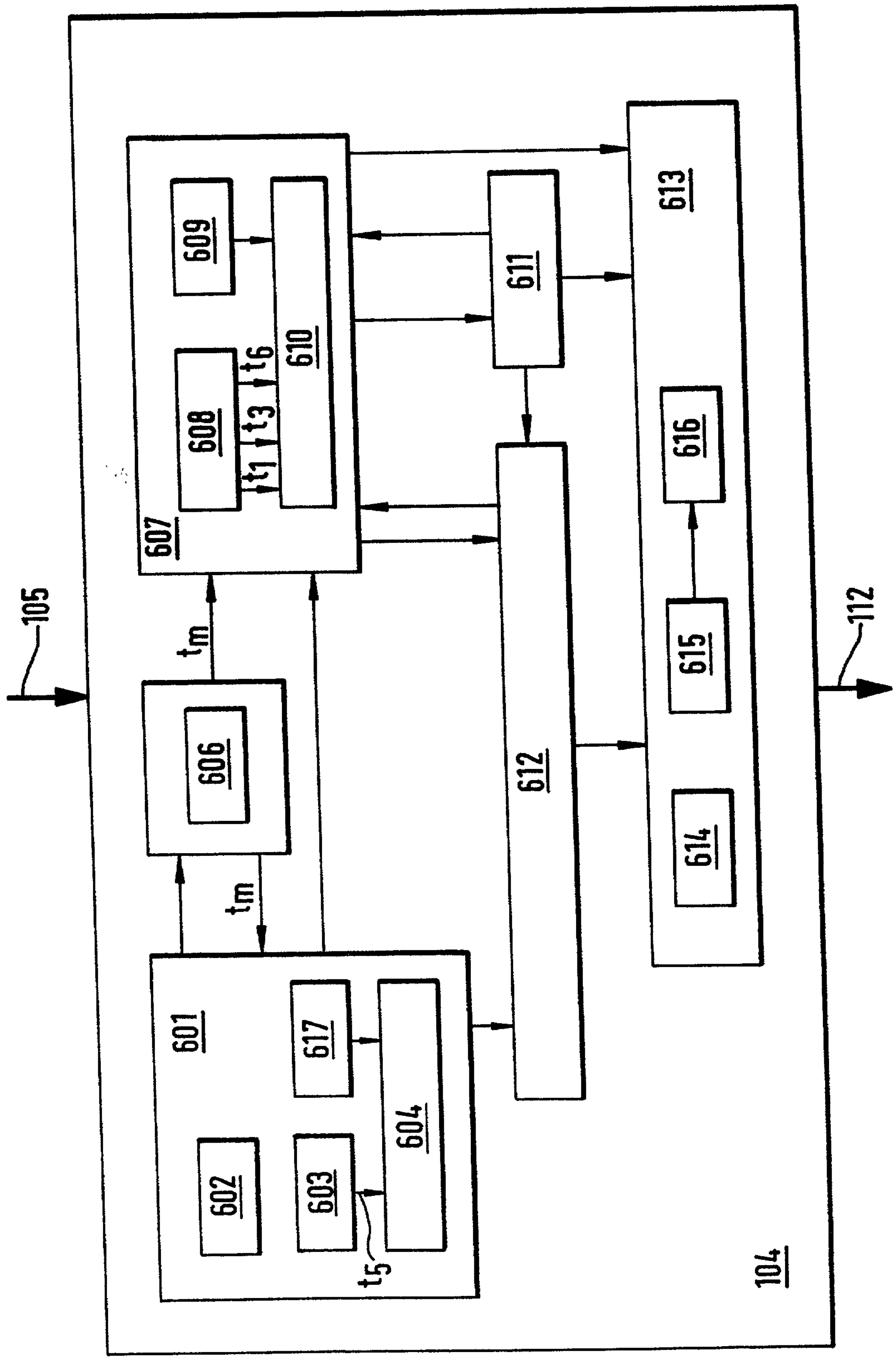

105
112
104
601
602
603
604
617
t_5
606
t_m
t_m
607
608
609
610
t_1
t_3
t_6
611
612
613
614
615
616

Fig. 7

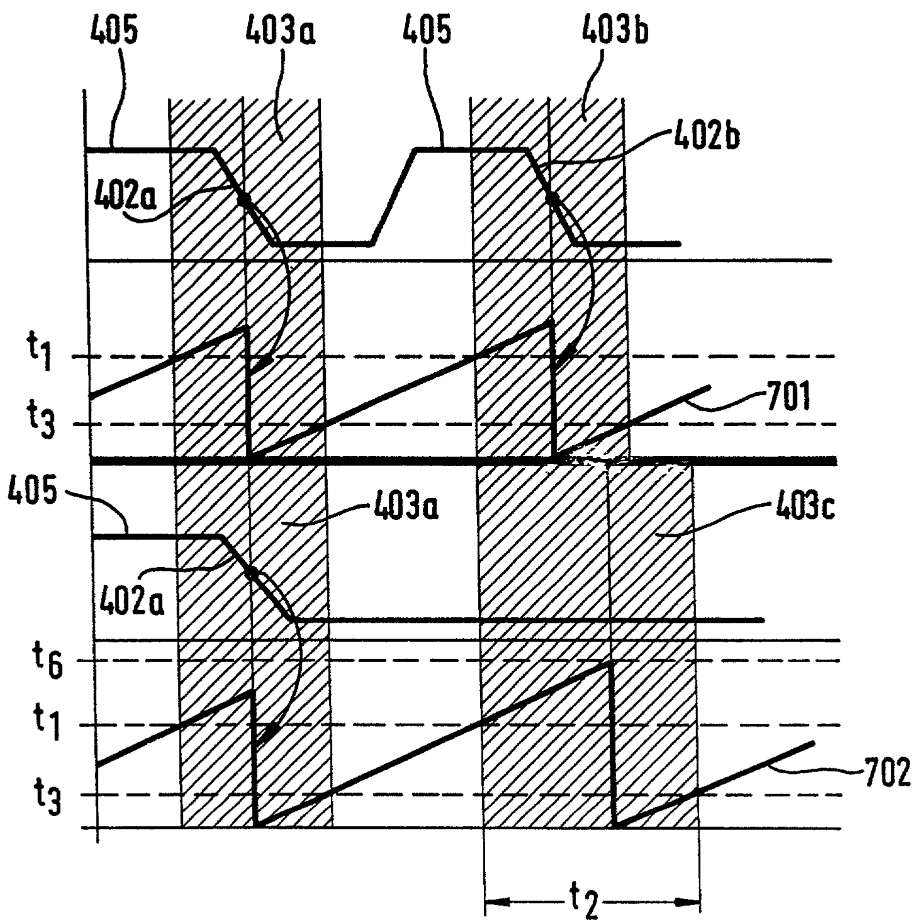

405
403a
405
403b
402b
402a
t1
t3
701
405
403a
403c
402a
t6
t1
t3
702
t2

Fig. 8a

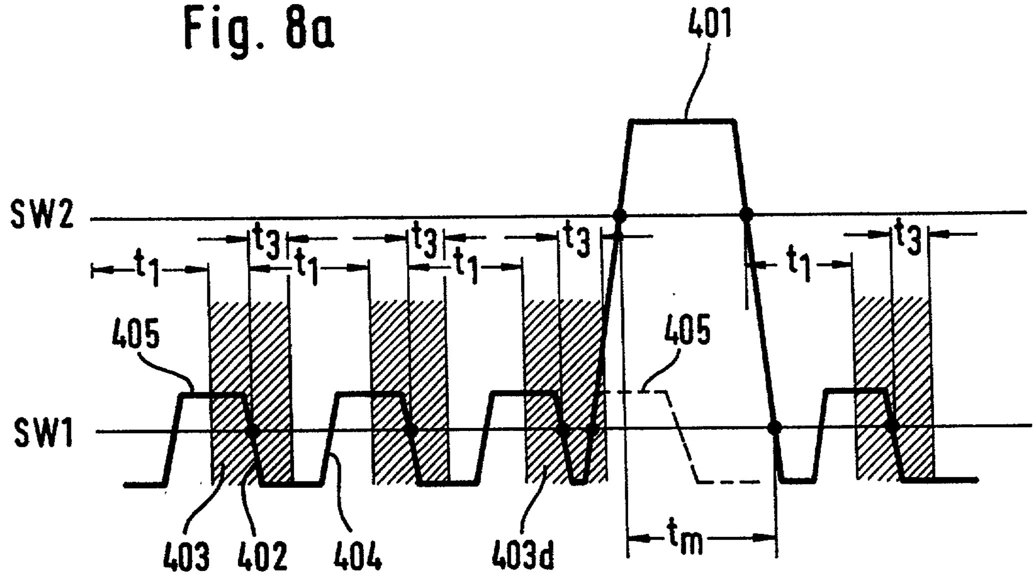
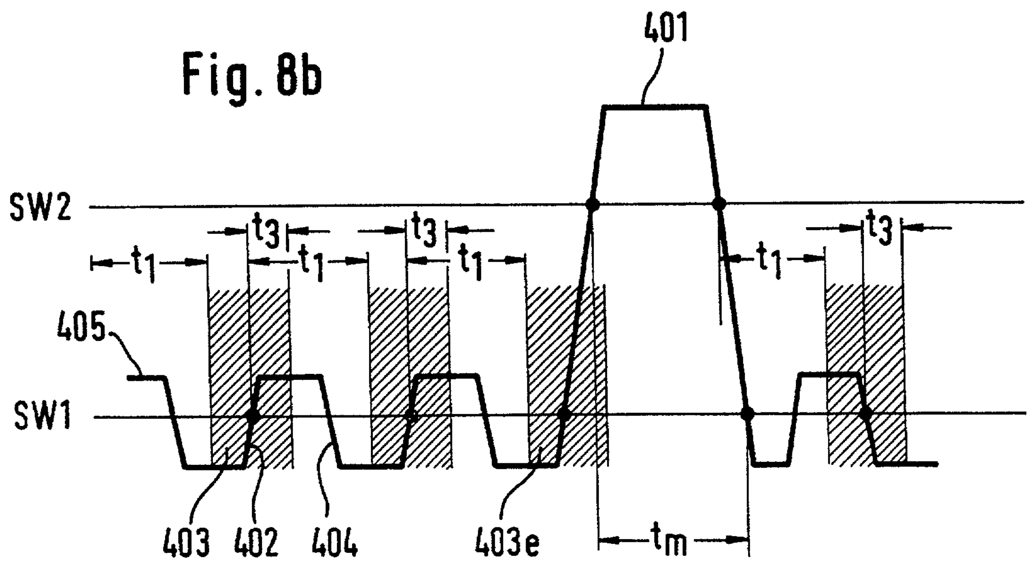
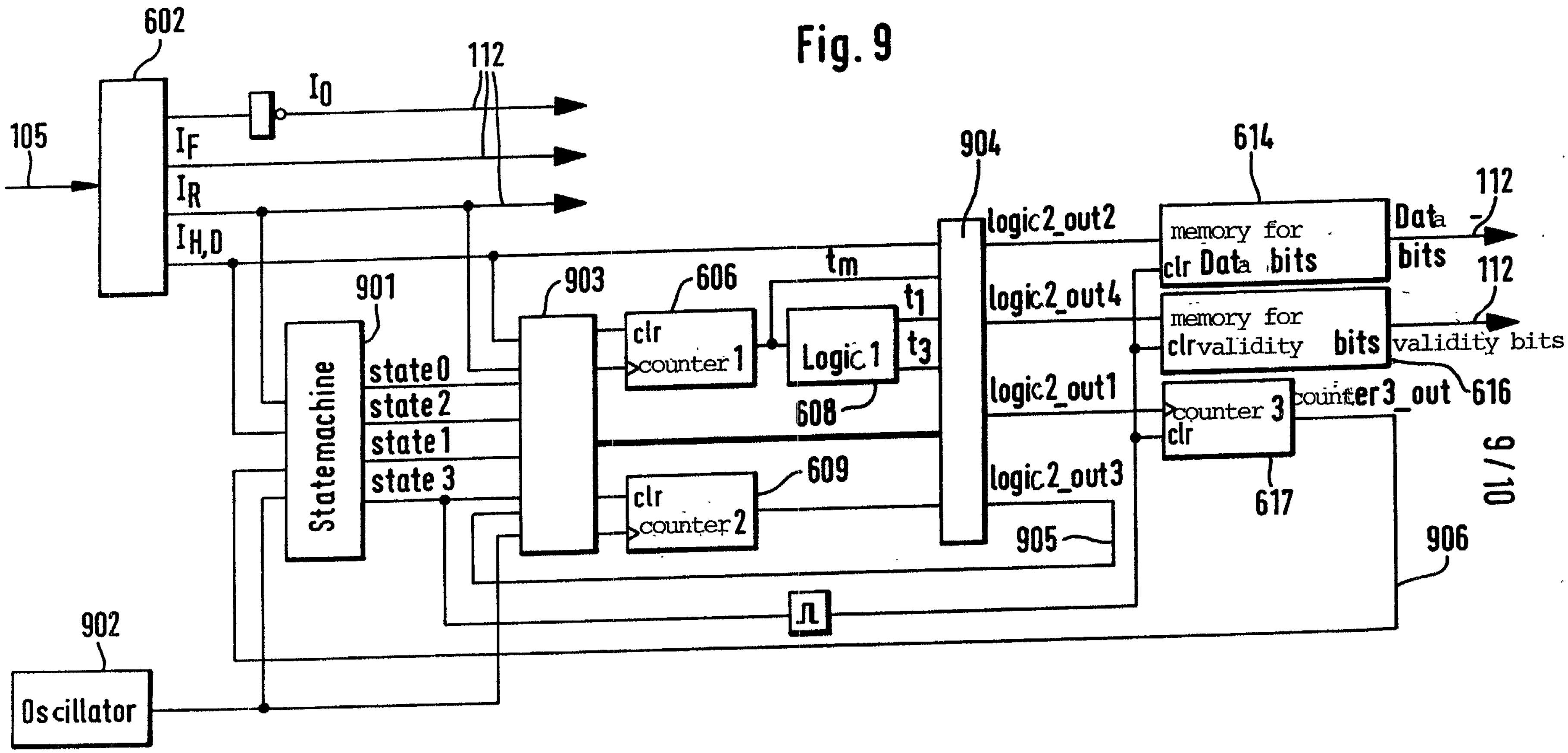

401
SW2
t3
t1
405
SW1
403
402
404
403d
tm

Fig. 8b


401
SW2
t3
t1
405
SW1
403
402
404
403e
tm

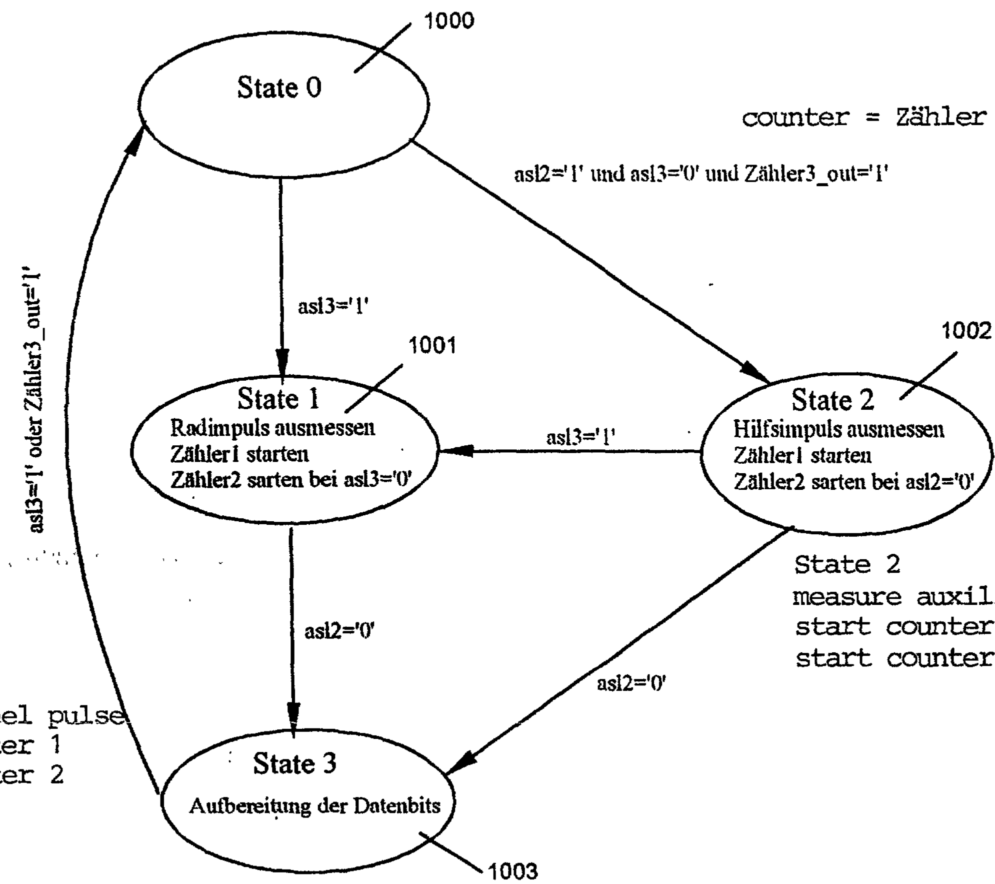
9/10

Fig. 9



09/830516

counter = Zähler



State 2
measure auxiliary pulse
start counter 1
start counter 2 at asl2='0'

State 1
measure wheel pulse
start counter 1
start counter 2
at asl3='0'

State 3
conditioning of the
data bits

FIG. 10

AP9455

Declaration and Power of Attorney for Patent Application
Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☒ wurde angemeldet am
unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die durch einen oben erwähnten Zusatzantrag und in einem „preliminary amendment" abgeändert wurden, durchgesehen und verstanden habe.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die eventuell zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method and Device for Conditioning a Received Signal that Transmits Coded Data

the specification of which is attached hereto unless the following box is checked:

☒ was filed on **13/October/1999**
as United States Application Number or PCT International Application Number
PCT/EP99/07684

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and as amended in a preliminary amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal
Regulations, § 1.56.

Attorney's Docket No: AP9455

PTO/SB/103 (8-96)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

g:PATENT/Formal matters/Declaration AP9455 (64098-871).DOC

German Language Declaration

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder §365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch ankreuzen sämtliche Auslands- anmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

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Prior Foreign Applications
(Frühere ausländische Anmeldungen)

			Priority Not Claimed Priorität nicht beansprucht
198 49 408.4	**Germany**	**27/October/1998**	☐
Number	Country	Day/Month/Year Filed	☐

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

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Application No. , filed on

Application No. , filed on

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I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Application No. , filed on — Status: patented/pending/abandoned)

Application No. , filed on — Status: patented/pending/abandoned)

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den (die) nachstehend aufgeführten Patentanwalt (Patentanwälte) und/oder Vertreter mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent- und Markenamt:

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☐ If box is checked, subsequent inventors are listed on a separate sheet

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